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SUPERFUND TREATABILITY CLEARINGHOUSE

Document Reference:

Tierman, T.O., Ph.D., "Development of Treatment Data on the KPEG Process for CERCLA/BDAT Standards." Approximately 60 pp. Prepared for U.S. EPA, HWERL. January 1988.

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SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process:	Physical/Chemical - Dechlorination
Media:	Soil/Generic
Document Reference:	Tierman, T.O., Ph.D., "Development of Treatment Data on the KPEG Process for CERCLA/BDAT Standards." Approximately 60 pp. Prepared for U.S. EPA, HWERL. January 1988.
Document Type:	Contractor/Vendor Treatability Study
Contact:	C. Rodgers U.S. EPA, HWERL Cincinnati, OH 45268 513-569-7757
Site Name:	BDAT SARM - Manufactured Waste (Non-NPL)
Location of Test:	Wright State University, Dayton, Ohio

BACKGROUND: This report describes the results of laboratory studies on KPEG treatment of synthetic soils contaminated with a variety of compounds, both organic and inorganic. The U.S. EPA provided soils to Wright State University to conduct the KPEG study. Problems were encountered in obtaining homogeneous soil samples and in the analysis of contaminants in the soils and in the analysis for VOCs in the reaction products of the KPEG treatment tests.

OPERATIONAL INFORMATION: EPA provided 50 pounds each of four different standard analytical reference matrix (SARM) samples which were prepared under a separate work assignment. Each of the soil samples were spiked with different concentrations of known volatile organic compounds (ethylbenzene, xylene, tetrachloroethylene, chlorobenzene, styrene, 1,2-dichloroethane and acetone), three semi-volatiles (anthracene, bis (2-ethylhenyl) phtalate and pentachlorophenol) and seven metals (Cd, Ca, Cr, Pb, As, Ni and Zn). The authors found the SARM soil samples to be non-homogenous with condensation and pooling of the liquid contaminants occurring in the soil samples. Samples could not be homogenized due to the high moisture content of the sample. 500 gram aliquots of the SARM soils were removed, placed in a two liter reaction vessel and reacted with KPEG for 1 hour at 100^{o}C to observe if the KPEG process effectively removed certain contaminants. The KPEG reagent was provided by the U.S. EPA. Samples before and after treatment were measured by purge/trap GC/MS. The analytical procedures had to be extensively modified due to the high levels of contaminants present in the reaction products. The author attributed the substantial scatter in the results to the problem of the nonhomogenous SARM that were used. Heavy metal analyses were performed by an EPA CLP Laboratory.

PERFORMANCE: The metal analysis in treated and untreated samples revealed that KPEG treatment and subsequent water washing did not reduce the metal concentrations. Overall metal materials balance was poor. The volatile

and semi-volatile organic data also exhibited very poor mass balance and a large scatter in results. However, the KPEG appears to have reacted with and essentially completely destroyed dichloroethane and tetrachloroethylene. The other two chlorinated organics were not destroyed since temperatures higher than 100°C are required to dechlorinate these compounds. The other organic compounds, xylene, ethylbenzene and styrene do not appear to be destroyed by this treatment. The acetone data is suspect due to volatility problems, instrument saturation, etc. A QA review could not be conducted due to the enormous concentrations of the analyte present in the various samples and the inapplicability of EPA analytical methods. The analytical data obtained are believed to be, at best, semi-quantitative indicators of the KPEG processes ability to treat contaminated soils.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminates by treatability group is:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Aromatic Compounds	108-90-7	Chlorobenzene
W03-Halogenated Phenols, Cresols and Thiols	87-86-5	Pentachlorophenol
W04-Halogenated Aliphatic Solvents	107-06-2	1,2-dichloroethane
	127-18-4	Tetrachloroethene
W07-Heterocyclics and Simple Aromatics	100-41-4	Ethylbenzene
	100-42-5	Styrene
	1330-20-7	Xylene (total)
W08-Polynuclear Aromatics	120-12-7	Anthracene
W09-Other Polar Organic Compounds	67-64-1	Acetone
	117-81-7	bis (2-ethyl hexyl) phthalate
W10-Non-Volatile Metals	7440-47-3	Chromium
	7440-50-8	Copper
	7440-02-0	Nickel
W11-Volatile Metals	7440-38-2	Arsenic
	7440-43-9	Cadmium
	7439-92-1	Lead
	7440-66-6	Zinc

ORD-TSI-RT-EU IV

WRIGHT STATE

Wright State University
Dayton, Ohio 45435

January 13. 1988

Ms. Judy L. Hessling
Work Assignment Manager
PEI Associates, Inc.
11499 Chester Road
Cincinnati, OH 45246

Dear Ms. Hessling:

Enclosed are two copies of the Final Report on our work accomplished under PEI Associates, Inc. Subcontract No. 777-87 to U.S. EPA Contract No. 68-03-3413, Work Assignment No. 0-2, PN 3741-2 with Wright State University. We have forwarded additional copies to U.S. EPA/HWERL (Cincinnati), Mr. Charles Rogers and to the designated EPA Washington Office.

If you have questions concerning the report, please don't hesitate to contact us.

Sincerely,

Thomas O. Tiernan, Ph.D.
Professor of Chemistry

Enclosure

copy: C. Rogers, U.S. EPA/HWERL
J. Knapp, CDM Federal Programs Corp.
J. Cunningham, U.S. EPA/Washington
B. Thompson, U.S. EPA/HWERL

FINAL REPORT

DEVELOPMENT OF TREATMENT DATA ON THE KPEG PROCESS FOR CERCLA/BDAT STANDARDS

ACCOMPLISHED UNDER PEI ASSOCIATES, INC. SUBCONTRACT NO. 777-87
TO U.S. EPA CONTRACT NO. 68-03-3413, WORK ASSIGNMENT NO. 0-6,
PN 3741-6, WITH WRIGHT STATE UNIVERSITY

Prepared By

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Submitted To

MS. JUDY L. HESSLING
WORK ASSIGNMENT MANAGER
PEI ASSOCIATES, INC.
11499 CHESTER ROAD
CINCINNATI, OHIO 45246

I. INTRODUCTION

Under PEI Associates, Inc. Subcontract No. 777-87 to U.S. EPA Contract No. 68-03-3413 (Work Assignment No. 0-6, PN 3741-6), Wright State University accomplished studies to generate bench-scale data on KPEG treatment of soils which were representative of those found at Superfund sites. Such soils contain a mixture of volatile and semivolatile organic and metallic contaminants. The data generated in this project is intended for use in setting best demonstrated available technology (BDAT) treatment standards for CERCLA soil and debris under the RCRA Hazardous and Solid Waste Amendments (HSWA) of 1984. More detailed information on the background and scope of this overall project is provided in the "Quality Assurance Project Plan (QAPP) for Development of Treatment Data on the KPEG Process for CERCLA/BDAT Standards" prepared by PEI Associates, Inc. and Wright State University (June, 1987), which was submitted to U.S. EPA. The Final Report describing the results of Wright State's work on this program are presented herein.

II. EXPERIMENTAL PROCEDURES

A. Soil Samples Tested In This Study

For the purposes of the study described herein, EPA provided PEI/WSU with approximately 50 lbs. of each of four standard analytical reference matrix samples (SARMS) which were prepared under a separate work assignment. Each of these soils was spiked with known concentrations of seven volatile organic compounds (ethylbenzene, xylene, tetrachloroethylene, chlorobenzene, styrene, 1,2-dichloroethane, and acetone), three semivolatile organic compounds (anthracene, bis(2-ethylhexyl) phthalate, and pentachlorophenol), and seven metals (cadmium, copper, chromium, lead, arsenic, nickel, and zinc). Each of the four soils were spiked at different concentrations with these chemicals and metals. The anticipated concentrations of these components are listed in the PEI/WSU Quality Assurance Project Plan (QAPP) mentioned earlier in this report.

The four SARMS just discussed were received from PEI (delivered by PEI personnel) at Wright State on July 24, 1987, well after the initially scheduled date. As projected in the Anticipated Project Schedule presented in the QAPP for this study, the KPEG treatment was originally scheduled to begin on July 1, 1987. Therefore, a significant delay was imposed on Wright State's work owing to this late receipt of the soil samples. The SARM samples were at ambient temperatures when delivered and had apparently not been refrigerated during transport. In order to minimize possible losses of the more volatile organic components, the sample containers were refrigerated immediately upon receipt by Wright State.

Upon receipt of the four SARMS, each of which was contained in a five-gallon metal can fitted with a compression lid and sealed with duct tape, the shipping containers were opened in

order to inspect the soils. The following observations were made regarding the condition of these samples. The indicated sample designation or identifying number is that which appeared on the sample container when it was received.

1. SARM-I-1

This sample was observed to be relatively wet and to have rust particles on the top surface. These particles had been dislodged from the inside of the container lid (which was adjacent to the soil) which had rusted or corroded, presumably after the sample had been packaged. Liquid condensate was visible on the inside of the lid of the five-gallon can containing the sample. Owing to the moisture content of this soil sample, it could not be mixed effectively before removing aliquots for treatment. Moreover, upon closer inspection, the soil was observed to contain small stones or soil agglomerates. These several observations clearly indicated that this soil sample was not homogeneous and it was therefore impossible to obtain a truly representative aliquot for use in the treatment tests.

2. SARM-II-1

This sample appeared to be relatively dry and no rust was observed on the inner lid of the sample container or on the top of the soil surface. Because this sample was drier, it could at least be stirred, in an effort to mix and homogenize it somewhat, before subsampling. As with the other samples, small stones or aggregates of soil particles were visible within the sample.

3. SARM-III-2

This sample was a thick mud and was virtually impossible to manipulate. The sample could not be stirred at all prior to subsampling. Again, liquid condensate was visible on the inside of the lid of the five-gallon sample container, and the lid had rusted or corroded. Rust particles had dropped from the lid onto the surface of the soil in the container.

4. SARM-IV-1

This sample was very wet and standing pools of liquid were visible in depressions in the soil surface. Again, liquid condensate and rust or corrosion were observed on the inner surface of the lid of the sample container and rust particles were visible on the top of the soil surface. It was impossible to effectively mix this sample, which was clearly inhomogeneous, prior to subsampling, and a truly representative aliquot could not be obtained for the KPEG treatment tests.

Following the initial inspection of the SARMS delivered to Wright State by PEI, the sample containers were resealed by replacing the lids, and information on the condition of the samples was communicated to U.S. EPA/HWERL (C. Rogers). Since

these SARMS were the only soils available for use in the KPEG tests, Wright State was instructed to proceed with the tests using these materials, and taking a sample in the best manner possible. However, it was requested that detailed information on the sample condition be provided in Wright State's report on the test results.

Immediately prior to the first series of KPEG destruction tests, which were conducted on Sept. 9-10, 1987, the SARM sample containers were again opened and aliquots were removed for use in the tests and for analyses. Four portions of soil were removed from each container (after briefly stirring the samples in cases where this was possible): a) approximately 500 grams of each soil were transferred to separate one-liter bottles fitted with Teflon-lined lids for use in the KPEG tests; b) approximately 40 grams of each soil were transferred to separate sample bottles for shipment to another laboratory for metals analyses, as instructed by EPA/PEI; c) approximately 40 grams of each soil were transferred to separate 40 mL VOA bottles (filled to the top) for retention as archive samples; d) additional portions, approximately 60 grams of each soil were transferred to separate amber bottles, again for retention as archive samples. Upon removal of this initial set of samples, the sample cans were again resealed by attaching the lids and resealing the lids with duct tape. The portions of the SARMS to be used in the KPEG destruction tests were taken immediately to the laboratory where these tests were conducted.

B. KPEG Treatment of the Soils

The procedures utilized for the KPEG treatment of the soils are detailed in the following. KPEG treatment was accomplished using four sets of reaction vessels, one for each soil, the reactions being run concurrently.

1. Apparatus

Each test apparatus consisted of a 2-liter reaction vessel mounted within a temperature-controlled heating mantle. A thermocouple was inserted between the reaction vessel and the mantle in order to monitor the temperature of the mantle itself. Each reaction flask was fitted with a cover which attached to the flask by a ground glass joint and a Teflon gasket, the seal being accomplished by a metal clamp. The top of each vessel incorporated four ground glass joint openings, through which equipment could be inserted. A motor-driven Teflon stirring shaft having 4 blades on the end within the flask was inserted through a water-cooled bearing into the center opening of the vessel top. This stirrer was operated at 100 rpm during the reaction. A thermometer with a ground glass joint was inserted through the second opening in the vessel lid to monitor the temperature of the reaction mixture. A ground glass joint attached to a nitrogen purge gas tube was inserted through the third opening in the reaction vessel. This permitted introduction of a nitrogen blanket over the reaction mixture

prior to heating in order to reduce the possibility of reaction/explosion of unstable organic products which might be evolved from the reaction mixture. Also, at the end of the reaction, the head-space of the reaction vessel was purged with N_2 through the condenser and solid sorbent trap in order to collect any remaining volatile organic reactants/products. Finally, through the last opening in the top of the reaction vessel, a water-cooled condenser fitted with a ground glass joint was inserted. At the top of the condenser a solid sorbent trap, packed with 7 grams of Tenax, 20 grams of XAD-2 resin, and 10 grams of activated carbon, was attached to trap any volatiles not condensed by the water-cooled condenser.

2. KPEG Reaction Test Procedures

The KPEG reagent used in these tests was supplied to Wright State directly by U.S. EPA/HWERL and was transported to Wright State by Mr. Charles Rogers of that organization. The label on the container of KPEG supplied by EPA and used in the tests described herein showed the following:

KPEG (400): 5 moles
KTEG (200): 5 moles
Prep. Sept. 4, 1987

The detailed procedures utilized for each of the four destruction reaction tests with the four SARMS were as follows:

a. Transfer the soil from the 1 L bottle to the 2 L reaction flask, and record the weight of soil transferred.

b. Add 200 mL of DMSO, and mix with a spatula until the mixture is homogeneous.

c. Add 50 g of solid KOH pellets and mix.

d. Assemble the apparatus described above.

e. Purge the reaction vessel with nitrogen gas for 10 minutes at a flow rate of 80 mL/min.

f. Add 400 mL of ambient temperature KPEG through an addition funnel.

g. Adjust the N_2 purge flow to 10 mL/min.

h. Stir the reaction mixture continuously for 30 min at ambient temperature.

i. Apply heat and increase the reaction mixture temperature (thermometer reading) to 100°C.

j. Maintain the 100°C temperature while stirring continuously, with continuous N_2 purge gas flow for a period of 2 hours.

k. Remove the heating mantle and allow the reaction mixture to cool to ambient temperature, while continuing stirring and purge flow.

l. Increase the N_2 purge gas flow to 80 mL/min for a period of 15 minutes, while continuing to stir the mixture.

m. Open the vessel and transfer the total reaction mixture to four 500 mL amber bottles and record the weights.

n. Transfer contents of the trap (tenax, XAD, activated carbon) to a 250 mL bottle, seal the bottle and refrigerate it.

o. Store all reaction products under refrigeration until further workup is accomplished.

In the course of these reactions, it was observed that condensation formed on the inside of the lid of the reaction vessel when the temperature was elevated to 100°C, but this disappeared when the reaction mixture was cooled to ambient temperature. Also, during the reaction, the stones or soil aggregates present in the SARMS were observed to settle to the bottom of the vessel.

The measured quantities of the SARMS and the reagents used in each of the four reactions in the first test series, as well as the quantities of solid sorbents used with each reaction vessel are shown in Table A.

3. Processing of KPEG Reaction Products-First Test Series

The reaction products derived from the first series of KPEG-treatment tests were processed according to the following procedures.

a. KPEG/Soil Separation Procedure

i) Remove the four 500 mL bottles containing each of the treated SARM samples from the storage refrigerator.

ii) Centrifuge the four bottles at 700 rpm for 15 minutes in a refrigerated centrifuge to separate the soil and KPEG phases.

iii) Decant the KPEG layer into a 500 mL amber glass bottle.

iv) Seal the bottle containing the KPEG phase and store it in the refrigerator.

v) Continue processing of the residual soil left in the original sample bottles, as described below.

b. Soil Washing Procedure

i) For each of the treated SARM samples, add 50 mL of HPLC grade (B&J) water to each of the four bottles containing the

residual soil (from which the KPEG has been separated).

ii) Place each bottle on a wrist action shaker and agitate for 30 minutes.

iii) Centrifuge the bottle at 700 rpm for 15 minutes in a refrigerated centrifuge to separate the aqueous and soil phases.

iv) Determine the pH of the aqueous phases with pH paper (the solution should be basic).

v) Transfer the aqueous liquid layer to a 500 mL amber glass bottle by decanting.

vi) Add another 50 mL of HPLC grade water to the soil in each of the four bottles, agitate the bottles for 30 minutes, and centrifuge, as described above.

vii) Remove the aqueous phase and pool it with the previous water wash in the 500 mL bottle. Seal the bottle and refrigerate it until just prior to preparation for GC-MS analysis.

viii) Seal the bottles containing the residual treated and washed soil and refrigerate then until just prior to preparation for GC-MS analysis.

The quantities of the several process samples resulting from KPEG-treatment of the four SARM samples (residual soil following washing, spent KPEG, spent washwater and spent solid sorbents in trap) are listed in Table B.

c. Preparation of Composite Treated Soil Sample for Analysis

Following the water washing just described, a representative composite sample of the KPEG-treated soil was prepared for analysis. This was accomplished by vigorously mixing the residual soil in each of the four bottles in which each treated soil was contained, then withdrawing equal aliquots of soil from each of the four bottles and combining these, again with vigorous mixing, in one new bottle, for each of the treated soils. The new bottles were then sealed with Teflon-lined lids and stored under refrigeration until just prior to analyses.

d. Shipment of Portions of Process Samples from KPEG Treatment of SARM Samples to Other Laboratories for Metals Analyses and TCLP Deliminations

As instucted by PEI in a Memorandum of Sept. 1, 1987, which was received from Judy Hessling of PEI, portions of the various process samples resulting from the KPEG treatment of the SARM samples, first test series, were packaged and shipped to two other laboratories. One of these sample sets, consisting of approximately 20 g. of each untreated SARM sample, 10 g. of each residual treated soil following washing, 20 mL of the spent KPEG reagent from each of the four tests, and 20 mL of the water used

to wash each of the four treated soils following treatment, was shipped by Federal Express under Chain-of-Custody, to Analytical Enterprises, Inc., Columbus, South Carolina, for metals analyses. A second shipment, consisting of several portions of the residual KPEG treated and water-washed soils only (three separate portions of approximately 70 g., 100 g. and 25 g., respectively, for each of the four treated SARM samples), were shipped by Federal Express under Chain-of Custody, to Wan Technologies, Atlanta, GA, for TCLP testing. Both of these shipments were shipped by Wright State University on Sept. 10, 1987.

4. KPEG Reaction Tests-Second Test Series

The second set of KPEG-treatment tests on the four SARM soil samples was conducted Nov. 3 - Nov.9, 1987. Immediately prior to this series of tests, the sample containers (5 gal. cans) were opened and aliquots of the samples were removed for use in the tests. The samples cans were then resealed by attaching the lids and resealing with duct tape.

The test apparatus and the experimental procedures employed for the second KPEG-treatment test series were quite similar to those applied for the first test series, as already described, with the following exceptions: a) 500 mL reaction flasks were used in this test series; b) approximately one-fourth of the quantities of soil and reagents used in the first test series were employed in the second test series (see Table C for exact quantities); c) the solid sorbent trap used in the second test series was packed sequentially with 10 g. of Tenax, and 25 g. of XAD-2 resin, and these sections were separated by a glass frit from a 12 g. section of activated carbon.

Following each treatment test, the entire contents of the reaction flask were transferred to a single 500 mL amber glass bottle fitted with a teflon-lined lid, and the bottle was sealed and refrigerated until just prior to phase separation. The Tenax-XAD-2 portion of the solid sorbent was transferred to a 100 mL amber glass bottle fitted with a Teflon-lined lid and the bottle was sealed and refrigerated until just prior to analysis. The charcoal portion of the trap was transferred to a separate bottle and retained.

The soil/KPEG separation and recovery procedures were exactly as described for the first test series (except that all of the treated sample mixture was contained in a single bottle, as already noted). The soil washing procedure utilized for the second test series was also just as described for the first test series except that only 100 mL of water was used here (two 50 mL portions for each of two wash cycles). The quantities of treated and washed soil, spent KPEG, spent wash water and spent solid sorbents resulting from the second test series are shown in Table D.

5. Materials, Chemicals and Reagents Used in Tests

The materials, chemicals and reagents used in these tests and the sources of these are as follows:

Reaction Vessel and Components	Ace Glass Inc.
Tenax GC, 35/60 mesh	Alltech Associates
XAD-2, 16/50 mesh	Supelco, Inc.
Charcoal, 6/14 mesh	Fisher Scientific
DMSO	Sigma Chemical Co.
KOH Pellets (A.C.S.)	Fisher Scientific
KPEG reagent, labelled: KPEG 400: 5 moles KTEG (200): 5 moles Prep. Sept. 4, 1987	C. Rogers/U.S. EPA/HWERL, Cincinnati, Ohio

C. Analyses of Reaction Products From KPEG Treatment Tests

1. Summary of Problems Encountered in Analyses

Prior to describing the analytical methods which were employed to characterize the reaction products resulting from KPEG-treatment of the SARM samples, it is appropriate to discuss the extensive problems which were encountered in attempting to analyze the products, and the rationale for the methods which were finally implemented. It was originally intended to apply EPA Methods 8240 and 8270 for the Volatile Organics and Semivolatile Organics, respectively. Owing to a variety of complications, however, these methods proved to be largely inapplicable for the analyses required here. The major source of problems encountered in the analyses originated from the huge concentrations of the analytes in the original soil samples, and even in the samples resulting from the treatment tests.

The magnitude of these concentrations was a problem because:

a. The high concentrations required that relatively small aliquots of both the untreated soil and the several samples resulting from KPEG treatment be selected for analyses, in an attempt to avoid overloading the analytical devices utilized. It is virtually impossible to select a sample aliquot which is truly representative of the entire bulk sample when such small samples are taken for analysis, especially when the bulk sample is not homogeneous and cannot be effectively mixed, as was the case here.

b. It was impossible to predict "a priori" the concentrations of the analytes which would be present in the various fractions from the treatment process, and therefore selection of portions of

these samples which would yield adequate detection limits for the analytes of interest, but would avoid saturating or overloading the analytical devices, was largely a matter of guess work. Unfortunately, very high concentrations of the organics were found to be present in many of these samples and therefore the "guesses" as to the portion of sample selected for analysis were frequently wrong. This led to repeated saturation of the instrumentation and numerous repetitive analyses to get even marginally acceptable data. The performance of the Tekmar Purge-Trap apparatus is especially devastated by being subjected to very high saturating concentrations of organics, and this resulted in long "memory" or holdup of the compounds in the Purge-Trap apparatus. The result was that carry-over of analytes (from the previous run) occurred in many of the analyses and eliminating this (which was never completely accomplished for acetone) required purging the apparatus for many hours and even days between analyses. This ultimately required literally <u>hundreds</u> of analyses to obtain even passable results.

c. The extremely high concentrations present and detected in many of the treated samples were often outside the range of instrument calibration, again requiring many extra analyses.

d. The standard EPA procedures for analyzing compounds such as those encountered in these studies, as documented in EPA's SW846 Manual (Methods 8240 and 8270), were not applicable for various reasons and had to be modified extensively. For example, pentachlorophenol (PCP) could not be detected at all in the samples by direct injection the sample extracts into the GC-MS, and it was necessary to acetylate or derivatize the PCP prior to injection. This essentially doubled the time normally required for such analyses.

e. The U.S. EPA software which is normally utilized for processing data obtained by EPA Methods 8240 and 8270 was not generally applicable for the analyses accomplished here because:

i) The EPA software is not designed to accomodate sample sizes smaller than 0.00001 Kg (0.01 gram). In many cases, in the present analyses, the size of the sample aliquot analyzed was necessarily less than 0.01 gram, because of the extraordinarily high concentrations of the analytes present in the samples.

ii) Even in cases where sample sizes were within the range of the EPA software, the extremely high concentrations of analytes present and detected usually exceeded the calculation capacity of the EPA program, and therefore final analytical results could not be automatically calculated using the EPA software. This also made it impossible to output the data in the customary EPA format, using the computer-generated data reporting sheets.

iii) For the reasons discussed, only the calibration curve could be generated using EPA software control and actual data calculations had to be accomplished almost entirely by manual methods.

f. As already discussed, there was strong evidence that the spiked soil samples provided by EPA/PEI were not homogeneous when received. Upon initial opening of the sample containers, condensation was observed on the can lid, and pools of liquid were apparent on the soil surface. The quantity of water present in the samples prevented effective mixing and representative subsampling. Finally, these soils were observed to contain rocks and other foreign matter which clearly indicated non-homogeneity and prevented accurate subsampling.

All of the above factors led to large variations in the analytical results and were directly responsible for the delays encountered in completing the analyses.

2. Sample Preparation - Volatiles

The procedure followed for preparation and analysis of various samples from the KPEG-treatment experiments are generally described in the U.S. EPA SW846 Manual, Method 8240. These methods were applied to the treated and water washed soil, the untreated soil, the spent KPEG, the spent wash water, and solid sorbent trap materials. Exceptions to these procedures are described in the following.

Initially, the assumption was made that levels of the target analyte compounds (the compounds with which the SARM samples were spiked) in the treated samples would be $\leq$ 1 mg/kg, due to destruction and/or volatilization, and the "Low-Level Method" for sediment/soil and waste samples which is described in section 7.4.3.1 of Method 8240, would therefore be applicable. Procedure 7.4.3.1 (the Low-Level Method) does not involve extraction of the sample and consumes only 250 ng of surrogate and internal standards for each analysis of a 1 to 5 g. portion of the sample. Results obtained for the samples however showed much higher levels of the target analytes than had been expected and therefore, insufficient standards were available to accomplish Procedure 7.4.3.1. In order to proceed with the project using the existing calibration standard and the calibration curves already established (in order to minimize delays) the surrogate spike was accomplished just prior to analysis in the present case. Therefore, less than 1 g. of high level samples were purged in the impinger, while samples with very high levels of the components were extracted with methanol (as described in 7.4.3.2), and then spiked with the surrogate/internal standard mixture prior to analysis.

In order to analyze the Tenax/XAD-2 samples, a thermal desorption accessory was constructed to heat the sorbent, and introduce the desorbed components directly into the Tekmar purge and trap apparatus for subsequent injection into the gas chromatograph (GC). The analysis procedure involved loading portions of the Tenax/XAD-2 sample into the thermal desorption accessory, spiking the sample with the surrogate/internal standards, and then heating the sorbent for 12 minutes at a

temperature at 180°C. Surrogate/Internal Standard 109086-1, described in the following section of this report, was used in these determinations.

3. Sample Preparation - Semi-Volatiles

The semi-volatile extraction procedure was adapted from SW-846, Method 3550, which is specified to be useful for "soils, sludges and wastes". The same extraction procedure was used for the untreated soil, treated and water-washed soil, spent wash water and spent KPEG, because the spent wash water contained some KPEG, and both the spent wash water and the spent KPEG contained small amounts of soil. The standards added during sample preparation (which are described in the following section of this report) were:

Surrogate Standards	109084-2
Internal Standards	109084-9

The sample preparation procedure involved the following steps:

a. Weighed 0.1 g to 1 g of the sample into a 40 mL vial.

b. Acidified the sample with 50% H_2SO_4 (to quench the KPEG reagent, and allow extraction of PCP).

c. Added 10 mL of methylene chloride.

d. The soil was very finely divided (except for small stones or aggregates) and shaking completely distributed the soil into the liquid phases. The samples were vigorously shaken for 10 minutes on a wrist action shaker.

e. Centrifuged the sample for 10 minutes at 1500 rpm to separate phases.

f. Collected the CH_2Cl_2 layer.

g. The CH_2Cl_2 layer was passed through a 3 cm plug of glass wool packed in a 10 mL pipet to remove any soil particles in the extract. The glass wool plug was rinsed with two 3 mL methylene chloride rinses and these were combined with the CH_2Cl_2 fraction.

h. Reduced the volume to less than 10 mL using a gentle stream of nitrogen at ambient temperature.

i. Adjusted the volume of the extract to 10.0 mL by adding CH_2Cl_2.

j. 5 mL to 50 µL of sample were removed for sample analysis. (the volume withdrawn depending on the estimated level of analytes in the sample).

k. Added standards to the sample.

l. Added 500 µL of tridecane to the sample.

m. Concentrated the sample using a gentle stream of nitrogen at ambient temperature to a volume of less than 1 mL.

n. Diluted the sample with isooctane to yield a 1 mL final volume.

o. Concentration of Standards in the final solution were:

Surrogate Stds.	10 ng/mL
Internal Stds.	40 ng/mL

4. Sample Preparation - Pentachlorophenol (PCP)

Since pentachlorophenol was found to be nonchromatographable when semi-volatile sample fractions were directly introduced into the GC-MS, a derivatization procedure was employed to permit analysis of PCP. The procedure utilized is outlined below.

a. A portion of the sample extract (2 mL of the 10 mL prepared according to the semi-volatile extraction procedure reported earlier) was reduced to near dryness at ambient temperature, in a 15 mL vial.

b. The following were added to the sample:
2 mL of isooctane
2 mL of acetonitrile
25 mL of pyridine
10 mL of acetic anhydride

c. The mixture was agitated for 5 minutes on a wrist-action shaker.

d. 6 mL of 10 millimolar H_3PO_4 were added to the sample and it was agitated for an additional 2 minutes on a wrist-action shaker.

e. The organic layer was removed and transferred to a vial and the volume was reduced to near dryness at ambient temperature.

f. Rediluted the sample with 1.0 mL of isooctane, and then added 20 µL of Standard No. 109084-9 to each sample.

5. Calibration and Spiking Standards

a. Volatile Standards Preparation

The volatile standards used in these analyses and the source of these, as well as the standards preparation procedures are described in the following:

i) Sources of Standard Materials

a) Ethyl benzene, Supelco, Inc.
b) Xylenes, Chem Service
c) Tetrachloroethylene, Supelco, Inc.

d) Chlorobenzene, Supelco, Inc.
e) Styrene, Chem Service
f) 1,2-dichloroethane, Supelco, Inc.
g) Acetone, Burdick and Jackson Labs Inc.

ii) Sources and Concentrations of Surrogate and Internal Standard Materials.

a) Surrogate Standards

i) d_{10}-ethylbenzene, 2 mg/mL, Supelco, Inc.
ii) d_4-1,2-dichloroethane, 250 mg/mL, Supelco, Inc.
iii) bromofluorobenzene, 250 mg/mL, Supelco, Inc.
iv) d_8-Toluene, 250 mg/mL, Supelco, Inc.

b) Internal Standards

i) bromochloromethane, 20 mg/mL, Supelco, Inc.
ii) 1-chloro-2-bromopropane, 20 mg/mL, Supelco, Inc.
iii) 1,4- dichlorobutane, 20 mg/mL, Supelco, Inc.
iv) d_6-benzene, 2 mg/mL, Supelco, Inc.

iii) Preparation of Volatile Calibration Standards

Prepare stock solutions of the seven native components by weighing each of the standard materials and diluting with methanol. Combine aliquots of the seven solutions to give a stock solution having a concentration of 100 mg/mL. Prepare dilutions to yield the following calibration standards:

a) Standard 109085-1, 100 ng/µL
b) Standard 109085-2, 50 ng/µL
c) Standard 109085-3, 12.5 ng/µL
d) Standard 109085-4, 2.5 ng/µL
e) Standard 109085-5, 0.5 ng/µL

iv) Surrogate and Internal Standards Mixture

Prepare Standard 109086-1 by combining the 8 surrogate and internal standards described above to provide the following concentrations in the final solution.

a) d_{10}-ethylbenzene, 225 ng/µL
b) d_4-1,2-dichloroethane, 25 ng/µL
c) bromofluorobenzene, 25 ng/µL
d) d_8-toluene, 25 ng/µL
e) bromochloromethane, 25 ng/µL
f) 1-chloro-2-bromopropane, 25 ng/µL
g) 1,4-dichlorobutane, 25 ng/µL
h) d_6-benzene, 25 ng/µL

b. Semi-Volatile Standards Preparation

The semi-volatile standards used in the analyses and the source of these, as well as the standards preparation procedures

we described in the following:

i) Sources of standard materials

a) Anthracene, Supelco, Inc.
b) DEHP, Supelco, Inc.
c) Pentachlorophenol, Supelco, Inc.

ii) Sources and concentrations of surrogate and internal standard materials

a) Surrogate Standards:

i) d_{10}-acthracene, 2 mg/mL, Supelco, Inc.
ii) $^{13}C_6$-pentachlorophenol, (solid - WSU prepared solution at 2 mg/mL), Cambridge Isotope Labs

b) Internal Standards:

i) d_{10}-acenaphthene
ii) d_{12}-chrysene
iii) d_4-1,4-dichlorobenzene
iv) d_8-naphthalene
v) d_{12}-perylene
vi) d_{10}-phenanthrene

All standards were at a concentration of 4000 µg/mL, as received from Alltech Associates, Inc.

iii) Semi-Volatile Standards Preparation

Prepare stock solutions of the 3 native components by weighing each of the standard materials and diluting in isooctane. Combine aliquots of the 3 solutions to give a stock solution with a concentration of 50 ng/mL

a) Prepared Standard 109084-2 (surrogate standards) which contains:

i) d_{10}-anthracene, 1000 ng/mL
ii) $^{13}C_6$-pentanchlorophenol, 1000 ng/mL

b) Prepared Standard 1090084-9 (internal standards) which contains:

i) d_{10}-acenaphthene, 2000 ng/mL
ii) d_{12}-chrysene, 2000 ng/mL
iii) d_4-1,4-dichlorobenzene, 2000 ng/mL
iv) d_8- naphthalene, 2000 ng/mL
v) d_{12}-perylene, 2000 ng/mL
vi) d_{10}-phenanthrene, 2000 ng/mL

c) Prepared calibration standards by combining the native, surrogate and internal standards to give the following concentrations.

Semi-volatile calibration standards

	Native Concentration	Surrogate Concentration	Internal Concentration
109084-4	40 ng/µL	40 ng/µL	40 ng/µL
109084-5	20	20	40
109084-6	10	10	40
109084-7	5	5	40
109084-8	1	1	40

c. Preparation of Semi-Volatile Calibration Standards for PCP Analysis.

i) 250 µL of each of the five semi-volatile calibration standards (109084-4 thru 109084-8) were transferred to 15 mL vials.

ii) The derivatization procedure for PCP, described above was applied to the standard mixture.

iii) Derivatized standards were rediluted to a final volume of 250 µL.

d. Instrumental Analyses - Apparatus and Procedures

i) Metal Analyses

As already noted, metals analyses were accomplished by a separate EPA contract laboratory using samples received from Wright State. Results at these analyses were provided to Wright State (measured concentrations of the metals in the samples) and Wright State converted the findings to total quantities of metals in the total treated samples, using weights of the total samples and of the aliquots which were provided to the other contract laboratory. This permitted calculation of percent recoveries of the several metals in the various KPEG treatment process samples. These results are described in the following sections of the report.

ii) GC-MS Analyses of Organics

a) Instrumentation - Volatiles Analyses

1) GC: HNU Systems model GC401

2) MS: Kratos MS-30

3) Data System: Kratos DS-90E

4) Interface: Glass Jet Separator

5) Operating Mode: EI ionization

6) GC Program: 80° C for 4 minutes 8° C/minute to 220° C and hold.

7) GC Column: 1% SP-1000 an 60/80 cardopack B. 1/8 inch x 8 feet.

8) Purge and Trap Apparatus: Tekmar Liquid Sample Concentrator LSC-2 parameters for purging and trapping as specified in EPA Method 8240.

b) Instrumentation - Semi-Volatiles Analyses

1) GC: Carlo Erba 5300 Mega Series

2) MS: Kratos MS-25

3) Data System: Kratos DS-90

4) Interface: Glass Jet Separator

5) Operating Mode: EI ionization

6) GC Program: 180° C for 8 minutes 8° C/minute to 300° C and hold.

7) GC Column: 60 meter DB-5, 0.25 mm film thickness; 0.25 mm ID.

8) GC Carrier Gas: H_2 at 2.5 kg/cm²

9) Injection Volume: 1 µL injection, in splitless mode

c) GC-MS Procedures - Semi-Volatiles

1) Tuning/Calibration: Tuning and calibration were accomplished using high boiling PFK.

2) Calibration Standards:

Native Compounds	Surrogates	Internal Standards
Anthracene	d_{10}-Anthracene	d_{10}-Phenanthrene
PCP	$^{13}C_{12}$-PCP	d_{10}-Phenanthrene
DEHP	----------	d_{12}-Chrysene

Standard Number	Concentration of each Native is ng/ul	Surrogate ng/ul	Internal ng/ul
109084-4 (CM-1)	40	40	40
109084-5 (CM-2)	20	20	40

109084-6 (CM-3)	10	10	40
109084-7 (CM-4)	5	5	40
109084-8 (CM-5)	1	1	40

3) Quantitation Ions: Ions used for quantitation varied somewhat from EPA suggested ions. In order to generate a standard curve with a 40-fold concentration difference, as required here, the sensitivity of Anthracene had to be decreased in relation to d_{12}-Chrysene, so less sensitive ions were chosen for quantitating Anthracene.

Compound	Primary Ion	Secondary Ion
Anthracene	176	179
PCP	266	264
DEHP	149	167
d_{10}-Anthracene	188	186
$^{13}C_{12}$-PCP	272	270
d_{10}-Phenanthrene	188	189
d_{12}-Chrysene	240	241

4) Initial MS Calibration: Kratos MS-25 hardware tuned using high boiling PFK; Calibrated mass range: 130-300.

5) GC Temperature Program: Initial column temperature and hold time: 180 C for 8 minutes; Column temperature program: 8 C/min; Final column temperature hold: 300 C

6) Other Temperatures: Injector temperature: 280 C; Transfer temperature line: 300 C; Source temperature: 300 C.

7) Other Parameters: Column: 60M DB-5 0.25 micron film thickness 0.25 mm ID; Injector: Grob-type, splitless; Injection volume: 1ul; Carrier gas: Hydrogen @50 cm/sec.

8) Operating Procedures: No background subtraction was required. Peaks were widely separated with good response factors so DDE/DDD degradation test was not run. Response factors were calculated for standard runs by EPA software using automatic peak detection and area calculations using the method listed in method 8270, page 13. Percent relative standard deviation for Response factors ranged from approximately 20 to 70 percent. Daily injections of the CM-4 standard were used to verify Response Factors.

Retention time data and correct response at the appropriate ions monitored were used for identification. Since this was a synthetic mixture formulated at extremely high levels, no interferences were expected (and none were observed.)

Quantitation was accomplished using a combination of EPA software and manual calculation. Since the EPA software was limited to sample sizes greater than 0.01 grams, all very high

level samples prepped with smaller sample sized were incompatable with the existing software. In addition, many samples had concentrations that exceeded the maximum calculation capacity of the program in micograms per kilogram. Actual results were calculated by forcing the EPA program to report values in ng/ul of the actual extract and then manually converting those values to total milligrams in the sample. Actual calculations therefore were similiar to those shown in method 8270, page 19, but were converted to yield total milligrams.

Quality control consisted of daily checks of the standard injection and appropriate analysis of method blanks. Since this was essentially a spiked sample program, no other lab spikes were required for analysis. Quality control limits could not be established since a minimum of 30 samples of the same matrix are required to generate meaningful statistics.

d) GC-MS Procedures - Volatiles

The standards and samples were introduced into the gas chromatograph by the purge-and-trap method except for the sorbent trap materials in which, they were heated in a specially designed apparatus and then trapped as described earlier.

The calibration procedure for the volatiles consisted of analyzing 5 different concentration levels of native compounds with the appropriate levels of internal and surrogate standards in each. Response factors were generated from these standards using the formula given in EPA Method 8240, section 7.2.7. A daily standard (one of the calibration standards) was checked against this calibration to verify the response factors.

Component identification was accomplished by using the relative retention time and characteristic ions for each particular volatile component. The appropriate ratio criteria were used for the characteristic ions. The samples were quantitated using the formula in Method 8240, section 7.5.2.2. Recoveries for the surrogate standards were calculated. Appropriate reagent blanks were analyzed to verify the system cleanliness for the components of interest.

These samples contained known analytes at such high concentrations that there were no possible interferences, which negated the need for library searches on the compounds. All analytes were of such high levels in most samples that extremely small sample sizes were necessary to carry out this procedure. This prevented. the MS software from directly calculating the final results. The MS, being a magnetic sector instrument negated the need for use of the 4-bromofluorobenzene tuning standard.

Mass calibration and other procedures not specifically discussed here were the same as described above for the semi-volatile analysis procedures.

III. RESULTS

A. Metals

The metals concentrations measured in aliquots of the four residual KPEG-treated and water-washed SARM soil samples, and in the spent KPEG and wash water, by Analytical Enterprises, Inc., which were reported to PEI/Wright State, were used by Wright State to calculate the total quantities of these metals in the residual soils, spent KPEG, and wash water. From these data, the percent recoveries of these metals in the various process fractions and the overall recoveries were calculated by Wright State. These results are summarized in Tables 1-4.

B. Volatile Organics

The measured concentrations of the target volatile organic constituents in the various sample fractions resulting from the first series of KPEG-treatment tests are shown in Table 5 and 6. The designation "UN" following a sample number in these tables (and in Tables 7-10) refers to the untreated soil. Similarly, the designations, "SO," "KP," "WA," and "XA," in Tables 5-10 refer to the treated and water-washed soil, the spent KPEG, the soil wash water, and the solid sorbent (used to trap evolved volatiles), respectively. The headings in these tables, "Acetone," "1,2-Di," "Tetrac," "Chloro," "Ethyl," "Xylene," and "Styren" refer to acetone, 1,2-dichloroethane, tetrachloroethylene, chlorobenzene, ethyl benzene and styrene, respectively.

The percent recoveries of the surrogate standards achieved in these analyses are summarized in Table 7.

Table 8-10 present data for the second series of KPEG-treatment tests which correspond to the data just described for the first test series.

In Table 11 and 12, the measured concentrations of the volatile organic constituents are converted to total quantities present in each of the sample fractions from the KPEG tests (residual soil, spent KPEG, wash water, solid sorbent trap), for the first and second test series, respectively. The total percent recoveries of these volatile organics in the entire sample set (that is, the percent remaining after the KPEG treatment) are also summarized in Table 11 and 12. This figure gives an indication of the destruction efficiency of the reaction for each analyte or alternatively, is a measure of losses by other mechanisms such as volatilization.

C. Semi-Volatile Organics

The measured concentrations of the target semi-volatile organic constituents in the various sample fractions resulting from the first series of KPEG-treated tests are shown in Tables 13 and 14. Corresponding data for the second KPEG-treatment tests are shown in Table 15 and 16. Tables 17 and 18 show the

results of Method Blank analyses, while Tables 19 and 20 summarize the percent recoveries of the surrogate standards which were achieved in these analyses. In Tables 21 and 22, the measured concentration data have been converted to show the total quantities of the semi-volatile constituents present in each of the treated residual soil, spent KPEG and washwater samples, for the first and second test series, respectively. Also shown in Tables 21 and 22 are the total percentages of the semi-volatile constituents recovered in the treated samples.

IV. DISCUSSION

Several general conclusions are possible from the data reported herein with respect to the KPEG-treatment process:

a. The metals data indicate that few of the metals were effectively removed from the soils by the KPEG treatment and, subsequent water washing. Probably this is due to the inorganic forms of the metals and their relatively poor aqueous solubilities. In retrospect, extraction of these could probably have been enhanced by using an acid water wash of the spent soil after KPEG treatment. The overall materials balance for the metals is quite poor, however.

b. The volatile and semi-volatile organic data also exhibit very poor materials balances, but it seems clear that both 1,2-dichloroethane and tetrachloroethylene have essentially been completely destroyed by the KPEG treatment. The other chlorinated organics, chlorobenzene and pentachlorophenol, were apparently not significantly affected by the KPEG treatment, which is not surprising, since it is known from other work, that destruction of these would have required higher temperatures than those used in the KPEG tests here. It was not practical to use such higher temperatures in these tests because of the flash points and volatility of the other organics (acetone, particularly) present in these samples. The hydrocarbons (xylene, ethylbenzene and styrene) in these samples were not expected to be affected by the KPEG treatment, and indeed no effects on degradation of these are discernible. The data for acetone are so suspect in view of volatility problems and instrument saturation, background and holdup, as to be generally unreliable.

c. Because of the enormous concentrations of most of the analytes present in virtually all of the samples for which analyses were attempted in this study, the standard U.S. EPA analytical methods (8240 and 8270) were largely inapplicable and data in the format normally presented for a Quality Assurance review could not be generated by the automated EPA software. Virtually all of the results had to be manually calculated. The mass chromatograms obtained in these analyses are available in our laboratory, and can be supplied upon request, if desired. These are not included herewith, since review of these would be virtually impossible without all of the parameters used in the manual calculations. The extensive problems encountered in this study with the

inadequate analytical procedures resulted in analytical data which are, at best, semi-quantitative indicators of the efficiency of the KPEG process.

TABLE A

QUANTITIES OF SOIL AND REAGENTS IN REACTION MIXTURES AND QUANTITY OF SOLID SORBENTS IN VAPOR TRAP FOR KPEG REACTION TESTS-FIRST SERIES

EPA/PEI SAMPLE NO.	SOIL	DMSO	KOH	KPEG	SOLID SORBENTS IN TRAP[a]
SARM-I-1	505.6 g	217.2 g	50.0 g	491.6 g	28.8 g
SARM-II-1	506.0	219.9	50.0	482.5	27.4
SARM-III-2	504.5	220.8	50.0	486.3	27.9
SARM-IV-1	502.9	217.9	50.0	483.5	30.5

a. XAD-2 and tenax only, the activated carbon portion of the vapor trap was not used for VOA analysis, since previous experience demonstrated it could not be effectively desorbed.

TABLE B

QUANTITIES OF VARIOUS SAMPLE FRACTIONS RESULTING FROM KPEG TREATMENT OF SARM SAMPLES FOLLOWING SEPARATION AND WASHING OF RESIDUAL SOIL

EPA/PEI SAMPLE NO.	TREATED AND WATER-WASHED SOIL	SPENT KPEG	SPENT WASH WATER	SPENT SOLID SORBENTS IN TRAP[a]
SARM-I-1	572.7 g	594.1 g	466.4 g	28.8 g
SARM-II-1	529.2	625.0	477.5	27.4
SARM-III-2	552.2	612.6	471.6	27.9
SARM-IV-1	462.7	662.9	500.0	30.5

a. XAD-2 and Tenax only; the activated carbon portion of the vapor trap was not used for VOA analysis, since previous experience demonstrated that it could not be effectively desorbed.

TABLE C

QUANTITIES OF SOIL AND REAGENTS IN REACTION MIXTURES AND QUANTITIES OF SOLID SORBERTS IN VAPOR TRAP FOR KPEG REACTION TESTS - SECOND SERIES

EPA/PEI SAMPLE NO.	SOIL	DMSO	KOH	KPEG	SOLID SORBENTS IN TRAP[a]
PEI7-1-1A/ SARM-I-1	105.3 g	53.3 g	12.6 g	145.9 g	34.7 g
PEI7-2-1A/ SARM-II-1	106.9	55.1	12.6	155.6	35.3
PEI7-3-1A/ SARM-III-2	116.7	54.0	12.5	157.0	36.6
PEI7-4-1A/ SARM-IV-1	97.9	53.9	11.5	142.4	35.7

a. XAD-2 and Tenax only; the activated carbon portion of the vapor trap was not used for VOA analysis, since previous experience demonstrated that it could not be effectively desorbed.

TABLE D

QUANTITIES OF VARIOUS SAMPLE FRACTIONS RESULTING FROM KPEG TREATMENT OF SARM SAMPLES FOLLOWING SEPARATION AND WASHING OF RESIDUAL SOILS

EPA/PEI SAMPLE NO.	TREATED AND WATER-WASHED SOIL	SPENT KPEG	SPENT WASH WATER	SPENT SOLID SORBENTS IN TRAP[a]
PEI7-1-1A/ SARM-1-1	89.0 g	210.0 g	113.1 g	34.7 g
PEI7-2-1A/ SARM-II-1	130.7	179.9	122.2	35.3
PEI7-3-1A/ SARM-III-2	130.4	190.3	116.5	36.6
PEI7-4-1A/ SARM-IV-1	115.7	178.9	120.8	35.7

a. XAD-2 and Tenax only; the activated carbon portion of the vapor trap was not used for VOA analysis, since previous experience demonstrated that it could not be effectively desorbed.

Table

RECOVERY OF METALS IN STANDARD ANALYTICAL REFERENCES MATRIX

	SAMPLE WEIGHT	LEAD FOUND ug/g	LEAD TOTAL	NICKEL FOUND ug/g	NICKEL TOTAL
UNTREATED SOIL I-1	505.60 g	304.00	153702.40 ug	68.00	34380.80 ug
TREATED SOIL I-1	572.70 g	195.00	111676.50 ug	32.00	18326.40 ug
WASH WATER I-1	466.40 g	6.80	3171.52 ug	2.00	932.80 ug
SPENT REAGENT I-1	594.10 g	18.00	10693.80 ug	8.40	4990.44 ug
		TOTAL	125541.82	TOTAL	24249.64
% REC IN SOIL			72.66	% REC IN SOIL	53.30
OVERALL REC			81.68	OVERALL REC	70.53
UNTREATED SOIL III-2	504.50 g	14451.00	7290529.50 ug	2409.00	1215340.50 ug
TREATED SOIL III-2	552.20 g	11350.00	6267470.00 ug	1615.00	891803.00 ug
WASH WATER III-2	471.60 g	1970.00	929052.00 ug	4.40	2075.04 ug
SPENT REAGENT III-2	612.60 g	1435.00	879081.00 ug	3.00	1837.80 ug
		TOTAL	8075603.00	TOTAL	895715.84
% REC IN SOIL			85.97	% REC IN SOIL	73.38
OVERALL REC			110.77	OVERALL REC	73.70
UNTREATED SOIL IV-1	502.90 g	17175.00	8637307.50 ug	2448.00	1231099.20 ug
TREATED SOIL IV-1	462.70 g	9827.00	4546952.90 ug	2332.00	1079016.40 ug
WASH WATER IV-1	500.00 g	1836.00	918000.00 ug	2.60	1300.00 ug
SPENT REAGENT IV-1	662.90 g	977.00	647653.30 ug	8.70	5767.23 ug
		TOTAL	6112606.20	TOTAL	1086083.63
% REC IN SOIL			52.64	% REC IN SOIL	87.65
OVERALL REC			70.77	OVERALL REC	88.22
UNTREATED SOIL II-1	506.00 g	379.00	191774.00 ug	70.00	35420.00 ug
TREATED SOIL II-1	529.20 g	169.00	89434.80 ug	33.00	17463.60 ug
WASH WATER II-1	477.50 g	18.20	8690.50 ug	2.20	1050.50 ug
SPENT REAGENT II-1	625.00 g	29.00	18125.00 ug	13.00	8125.00 ug
		TOTAL	116250.30	TOTAL	26639.10
% REC IN SOIL			46.64	% REC IN SOIL	49.30
OVERALL REC			60.62	OVERALL REC	75.21

Table

RECOVERY OF METALS IN STANDARD ANALYTICAL REFERENCES MATRIX

	SAMPLE WEIGHT	CHROMIUM FOUND ug/g	CHROMIUM TOTAL	COPPER FOUND ug/g	COPPER TOTAL
UNTREATED SOIL I-1	505.60 g	30.00	15168.00 ug	349.00	176454.40 ug
TREATED SOIL I-1	572.70 g	21.00	12026.70 ug	251.00	143747.70 ug
WASH WATER I-1	466.40 g	0.97	452.41 ug	13.00	6063.20 ug
SPENT REAGENT I-1	594.10 g	0.02	11.88 ug	7.90	4693.39 ug
		TOTAL	12490.99	TOTAL	154504.29
% REC IN SOIL			79.29	% REC IN SOIL	81.46
OVERALL REC			82.35	OVERALL REC	87.56
UNTREATED SOIL III-2	504.50 g	1163.00	586733.50 ug	11678.00	5891551.00 ug
TREATED SOIL III-2	552.20 g	826.00	456117.20 ug	6736.00	3719619.20 ug
WASH WATER III-2	471.60 g	168.00	79228.80 ug	281.00	132519.60 ug
SPENT REAGENT III-2	612.60 g	2.20	1347.72 ug	38.00	23278.80 ug
		TOTAL	536693.72	TOTAL	3875417.60
% REC IN SOIL			77.74	% REC IN SOIL	63.13
OVERALL REC			91.47	OVERALL REC	65.78
UNTREATED SOIL IV-1	502.90 g	1407.00	707580.30 ug	10928.00	5495691.20 ug
TREATED SOIL IV-1	462.70 g	918.00	424758.60 ug	9381.00	4340588.70 ug
WASH WATER IV-1	500.00 g	174.00	87000.00 ug	454.00	227000.00 ug
SPENT REAGENT IV-1	662.90 g	13.00	8617.70 ug	310.00	205499.00 ug
		TOTAL	520376.30	TOTAL	4773087.70
% REC IN SOIL			60.03	% REC IN SOIL	78.98
OVERALL REC			73.54	OVERALL REC	86.65
UNTREATED SOIL II-1	506.00 g	33.00	16698.00 ug	376.00	190256.00 ug
TREATED SOIL II-1	529.20 g	23.00	12171.60 ug	330.00	174636.00 ug
WASH WATER II-1	477.50 g	8.20	3915.50 ug	20.00	9550.00 ug
SPENT REAGENT II-1	625.00 g	0.02	12.50 ug	17.00	10625.00 ug
		TOTAL	16099.60	TOTAL	194811.00
% REC IN SOIL			72.89	% REC IN SOIL	91.79
OVERALL REC			96.42	OVERALL REC	102.39

RECOVERY OF METALS IN STANDARD MATRIX

	SAMPLE WEIGHT	ANALYTICAL ARSENIC FOUND ug/g	REFERENCE ARSENIC TOTAL		CADMIUM FOUND ug/g	CADMIUM TOTAL	
UNTREATED SOIL I-1	505.60 g	20.00	10112.00	ug	45.00	22752.00	ug
TREATED SOIL I-1	572.70 g	8.10	4638.87	ug	21.00	12026.70	ug
WASH WATER I-1	466.40 g	8.20	3824.48	ug	1.50	699.60	ug
SPENT REAGENT I-1	594.10 g	0.04	23.76	ug	2.40	1425.84	ug
		TOTAL	8487.11		TOTAL	14152.14	
% REC IN SOIL			45.87		% REC IN SOIL	52.86	
OVERALL REC			83.93		OVERALL REC	62.20	
UNTREATED SOIL III-2	504.50 g	359.00	181115.50	ug	3488.00	1759696.00	ug
TREATED SOIL III-2	552.20 g	184.00	101604.80	ug	861.00	475444.20	ug
WASH WATER III-2	471.60 g	0.00	0.00	ug	1.80	848.88	ug
SPENT REAGENT III-2	612.60 g	1.20	735.12	ug	4.50	2756.70	ug
		TOTAL	102339.92		TOTAL	479049.78	
% REC IN SOIL			56.10		% REC IN SOIL	27.02	
OVERALL REC			56.51		OVERALL REC	27.22	
UNTREATED SOIL IV-1	502.90 g	338.00	169980.20	ug	6148.00	3091829.20	ug
TREATED SOIL IV-1	462.70 g	168.00	77733.60	ug	4855.00	2246408.50	ug
WASH WATER IV-1	500.00 g	458.00	229000.00	ug	4.50	2250.00	ug
SPENT REAGENT IV-1	662.90 g	96.00	63638.40	ug	7.10	4706.59	ug
		TOTAL	370372.00		TOTAL	2253365.09	
% REC IN SOIL			45.73		% REC IN SOIL	72.66	
OVERALL REC			217.89		OVERALL REC	72.88	
UNTREATED SOIL II-1	506.00 g	20.00	10120.00	ug	59.00	29854.00	ug
TREATED SOIL II-1	529.20 g	8.70	4604.04	ug	34.00	17992.80	ug
WASH WATER II-1	477.50 g	8.60	4106.50	ug	1.80	859.50	ug
SPENT REAGENT II-1	625.00 g	0.04	25.00	ug	6.30	3937.50	ug
		TOTAL	8735.54		TOTAL	22789.80	
% REC IN SOIL			45.49		% REC IN SOIL	60.27	
OVERALL REC			86.32		OVERALL REC	76.34	

Table

RECOVERY OF METALS IN STANDARD ANALYTICAL REFERENCES MATRIX

	SAMPLE WEIGHT	ZINC FOUND ug/g	ZINC TOTAL	
UNTREATED SOIL I-1	505.60 g	1028.00	519756.80	ug
TREATED SOIL I-1	572.70 g	492.00	281768.40	ug
WASH WATER I-1	466.40 g	3.70	1725.68	ug
SPENT REAGENT I-1	594.10 g	3.30	1960.53	ug
		TOTAL	285454.61	
% REC IN SOIL			54.21	
OVERALL REC			54.92	
UNTREATED SOIL III-2	504.50 g	24262.00	12240179.00	ug
TREATED SOIL III-2	552.20 g	973.00	537290.60	ug
WASH WATER III-2	471.60 g	1966.00	927165.60	ug
SPENT REAGENT III-2	612.60 g	566.00	346731.60	ug
		TOTAL	1811187.80	
% REC IN SOIL			4.39	
OVERALL REC			14.80	
UNTREATED SOIL IV-1	502.90 g	23414.00	11774900.60	ug
TREATED SOIL IV-1	462.70 g	14736.00	6818347.20	ug
WASH WATER IV-1	500.00 g	2576.00	1288000.00	ug
SPENT REAGENT IV-1	662.90 g	933.00	618485.70	ug
		TOTAL	8724832.90	
% REC IN SOIL			57.91	
OVERALL REC			74.10	
UNTREATED SOIL II-1	506.00 g	1725.00	872850.00	ug
TREATED SOIL II-1	529.20 g	1269.00	671554.80	ug
WASH WATER II-1	477.50 g	10.00	4775.00	ug
SPENT REAGENT II-1	625.00 g	11.00	6875.00	ug
		TOTAL	683204.80	
% REC IN SOIL			76.94	
OVERALL REC			78.27	

Table 5

Wright State University, Dayton, Ohio 45435

Analysis for Destruction of Volatiles with KPEG-First Test Series

Concentrations Found (micrograms per gram of sample or parts-per-million)

PEI Sample Number		Aceton	1,2-Di	Tetrac	Chloro	Ethyl	Xylene	Styren
SARM-1-1	UN	7885	584	585	345	3917	10063	827
SARM-1	SO	3.46	ND 0.0018	0.140	0.106	1.05	3.67	0.367
SARM-1	KP	1815	ND 1.80	6.11	265	1852	5355	596
SARM-1	WA	1179	ND 0.0840	ND 0.118	55.0	220	650	92.3
SARM-1	XA	625	0.434	29.9	25.0	343	711	19.3
-2-1	UN	212	0.193	23.5	4.26	28.4	101	123
SARM-2	SOIL	7.59	0.0160	0.0129	0.0161	0.0718	0.247	0.0568
SARM-2	KP	89.3	ND 0.133	2.30	5.71	47.8	146	15.5
SARM-2	WA	3.28	0.0966	0.0376	1.82	9.86	35.3	5.16
SARM-2	XA	4.47	ND 0.0141	0.0900	0.240	3.48	11.5	8.07

a. The designation ND indicates "None Detected" in excess of the minimum detectable concentration which is listed directly below the ND designation.

Table 6

Wright State University, Dayton, Ohio 45435

Analysis for Destruction of Volatiles with KPEG-First Test Series

Concentrations Found (micrograms per gram of sample or parts-per-million)

PEI Sample Number		Aceton	1,2-Di	Tetrac	Chloro	Ethyl	Xylene	Styren
SARM-3-2	UN	496	6.63	27.2	13.1	188	500	40.5
SARM-3	SO	4.86	0.130	0.0068	0.0306	0.0918	0.280	0.0547
SARM-3	KP	59.4	ND 0.114	1.87	9.49	85.1	246	16.7
SARM-3	WA	17.8	ND 0.0205	ND 0.0420	2.18	13.6	31.8	1.80
SARM-3	XA	3.34	ND 0.0034	0.668	1.00	10.5	51.6	5.39
-4-1	UN	3059	151	1265	387	2916	7451	721
SARM-4	SO	3.35	ND 0.0030	0.156	0.0102	0.0623	0.216	0.0349
SARM-4	KP	1633	ND 1.79	4.89	246	1801	4950	496
SARM-4	WA	269	ND 0.128	ND 0.322	38.5	206	593	54.3
SARM-4	XA	11.6	0.149	1.90	1.75	38.1	75.5	5.49

a. The designation ND indicates "None Detected" in excess of the minimum detectable concentration which is listed directly below the ND designation.

Table 7

Wright State University, Dayton, Ohio 45435

Surrogate Standards Recoveries-First Test Series

PEI Sample Number		%Rec d4-DiChlo	%Rec d8-Toluen	%Rec d10-Ethyl	%Rec BromoFlor
SARM-1-1	UN	152	204	223	94
SARM-1	SO	103	80	62	131
SARM-1	KP	112	118	209	155
SARM-1	WA	60	97	105	162
SARM-1	XA	63	38	64	175
SARM-2-1	UN	72	96	71	224
SARM-2	SOIL	66	121	70	101
SARM-2	KP	94	104	113	143
SARM-2	WA	106	102	111	146
SARM-2	XA	86	83	129	116
SARM-3-2	UN	100	249	387	118
SARM-3	SO	100	89	93	152
SARM-3	KP	94	78	77	144
SARM-3	WA	52	66	67	163
SARM-3	XA	85	59	86	98
SARM-4-1	UN	57	100	153	286
SARM-4	SO	86	102	104	135
SARM-4	KP	102	133	192	143
SARM-4	WA	86	75	64	127
SARM-4	XA	78	76	172	91

Table 8

Wright State University, Dayton, Ohio 45435

Analysis for Destruction of Volatiles with KPEG-Second Test Series

Concentrations Found (micrograms per gram of sample or parts-per-million)

PEI Sample Number	Aceton	1,2-Di	Tetrac	Chloro	Ethyl	Xylene	Styren
SARM-1-1 UN	7885	584	585	345	3917	10063	827
SARM-1-1 SO	75.8	ND 0.0845	0.684	8.00	95.2	265	27.0
SARM-1-1 KP	1392	ND 0.807	ND 1.91	254	1894	5586	554
SARM-1-1 WA	230	ND 0.0370	ND 0.0548	35.2	163	413	79.0
SARM-1-1 XA	406	1.79	10.8	12.7	164	409	31.1
-2-1 UN	212	0.193	23.5	4.26	28.4	101	123
SARM-2-1 SO	14.7	ND 0.0262	2.21	0.146	0.882	2.92	0.488
SARM-2-1 KP	284	ND 0.912	1.48	4.40	47.6	155	17.4
SARM-2-1 WA	12.2	ND 0.0174	ND 0.0142	1.59	8.84	31.1	4.88
SARM-2-1 XA	28.3	ND 0.0698	0.854	ND 0.0552	2.17	5.38	20.1

a. The designation ND indicates "None Detected" in excess of the minimum detectable concentration which is listed directly below the ND designation.

Table 9

Wright State University, Dayton, Ohio 45435

Analysis for Destruction of Volatiles with KPEG-Second Test Series

Concentrations Found (micrograms per gram of sample or parts-per-million)

PEI Sample Number	Aceton	1,2-Di	Tetrac	Chloro	Ethyl	Xylene	Styren
SARM-3-2 UN	496	6.63	27.2	13.1	188	500	40.5
SARM-3-2 SO	15.6	ND 0.0200	1.27	0.457	3.05	9.76	0.766
SARM-3-2 KP	169	ND 0.384	2.29	8.05	76.5	244	18.1
SARM-3-2 WA	13.7	ND 0.0239	ND 0.0214	2.13	13.7	47.3	5.22
SARM-3-1 XA	42.3	0.0784	1.18	0.431	10.0	26.3	16.1
-4-1 UN	3059	151	1265	387	2916	7451	721
SARM-4-1 SO	250	ND 0.395	1.85	3.69	38.0	88.6	13.0
SARM-4-1 KP	1208	ND 1.07	ND 3.65	242	1769	5501	569
SARM-4-1 WA	13.2	ND 0.0571	0.503	25.7	82.1	265	66.6
SARM-4-1 XA	487	4.95	26.9	17.8	172	461	45.5

a. The designation ND indicates "None Detected" in excess of the minimum detectable concentration which is listed directly below the ND designation.

Table 10

Wright State University, Dayton, Ohio 45435

Surrogate Standards Recoveries-Second Test Series

PEI Sample Number	%Rec d4-DiChlo	%Rec d8-Toluen	%Rec d10-Ethyl	%Rec BromoFlor
SARM-1-1 UN	152	204	223	94
SARM-1-1 SO	80	164	204	132
SARM-1-1 KP	93	184	183	119
SARM-1-1 WA	110	130	113	90
SARM-1-1 XA	89	71	66	121
SARM-2-1 UN	72	96	71	224
SARM-2-1 SO	91	85	80	86
SARM-2-1 KP	282	113	144	84
SARM-2-1 WA	105	109	98	125
SARM-2-1 XA	94	167	257	101
SARM-3-2 UN	100	249	387	118
SARM-3-2 SO	86	69	82	91
SARM-3-2 KP	102	107	109	96
SARM-3-2 WA	143	120	143	98
SARM-3-1 XA	61	124	100	180
SARM-4-1 UN	57	100	153	286
SARM-4-1 SO	129	185	226	87
SARM-4-1 KP	76	175	193	144
SARM-4-1 WA	103	146	169	80
SARM-4-1 XA	119	81	75	122

Table

T TEST

SAMPLE NO M I

CONCENTRATION OF ANALYTE [illegible]

MATRIX	SAMPLE SIZE	CONC. ACETONE	QUANTITY IN TOTAL SAMPLE	CONC. 1,2 DI	QUANTITY IN TOTAL SAMPLE	CONC. TETRAC	QUANTITY IN TOTAL SAMPLE	CONC. CHLORO	QUANTITY IN TOTAL SAMPLE	CONC. ETHYL	QUANTITY IN TOTAL SAMPLE	CONC. XYLENE	QUANTITY IN TOTAL SAMPLE	CONC. XYLENE	QUANTITY IN TOTAL SAMPLE
UNTREATED SOIL	505.6	785.0	[illegible]	584.0	295[illegible].4	[illegible]	[illegible]	40.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TREATED SOIL	57[illegible]	5.5	1481.5	0.0	0.0	0.1	[illegible]	0.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
KPEG	[illegible].1	1815.0	1078[illegible].5	0.0	0.0	[illegible].1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
WATER	466.4	11[illegible]	543[illegible].6	0.0	0.0	0.1	[illegible]	[illegible]	585.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
XAD ././TENAX	29.8	[illegible]	18000.0	0.0	0.0	[illegible]	961.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL IN TREATED SOIL			1[illegible]8.6		0.0		401.3		[illegible]		[illegible]		[illegible]		[illegible]
% REMAINING (AMOUNT RECOVERED OR NOT DESTROYED)			41.3		0.0		[illegible]		105.4		[illegible]		[illegible]		[illegible]

SAMPLE NO. SAPM-II

MATRIX	SAMPLE SIZE	CONC. ACETONE	QUANTITY IN TOTAL SAMPLE	CONC. 1,2 DI	QUANTITY IN TOTAL SAMPLE	CONC. TETRAC	QUANTITY IN TOTAL SAMPLE	CONC. CHLORO	QUANTITY IN TOTAL SAMPLE	CONC. ETHYL	QUANTITY IN TOTAL SAMPLE	CONC. XYLENE	QUANTITY IN TOTAL SAMPLE	CONC. XYLENE	QUANTITY IN TOTAL SAMPLE
UNTREATED SOIL	506.0	212.0	107272.0	0.2	97.7	25.5	1124[illegible]	4.3	21[illegible]	[illegible].4	115[illegible].1	[illegible]	[illegible]	[illegible]	[illegible]
TREATED SOIL	528.2	7.6	4016.6	.0	[illegible].5	.0	5.3	.0	5.7	0.1	[illegible]	[illegible]	[illegible]	0.1	[illegible]
KPEG	625.0	89.5	55[illegible]12.5	0.0	0.0	[illegible]	11[illegible].5	5.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
WATER	477.5	3.3	1566.2	0.1	47.8	.0	14.3	1.8	861.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
XAD ././TENAX	27.1	4.5	12[illegible]	0.0	0.0	0.1	[illegible]	0.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.1	[illegible]
TOTAL IN TREATED SOIL			61517.8		56.2		1459.6		4445.7		[illegible]15.5		[illegible]		[illegible]
% REMAINING (AMOUNT RECOVERED OR NOT DESTROYED)			57.3		57.6		12.3		206.4		[illegible]		[illegible]		[illegible]

SAMPLE NO SAPM-III

MATRIX	SAMPLE SIZE	CONC. ACETONE	QUANTITY IN TOTAL SAMPLE	CONC. 1,2 DI	QUANTITY IN TOTAL SAMPLE	CONC. TETRAC	QUANTITY IN TOTAL SAMPLE	CONC. CHLORO	QUANTITY IN TOTAL SAMPLE	CONC. ETHYL	QUANTITY IN TOTAL SAMPLE	CONC. XYLENE	QUANTITY IN TOTAL SAMPLE	CONC. XYLENE	QUANTITY IN TOTAL SAMPLE
UNTREATED SOIL	504.5	496.0	1502[illegible].0	6.6	3344.0	[illegible]	157[illegible].4	13.1	6601.0	19[illegible].0	93846.0	500.0	[illegible]	[illegible]	[illegible]
TREATED SOIL	552.2	4.9	[illegible]5.7	0.1	71.0	0.0	0.0	.0	10.6	0.1	[illegible]	[illegible]	[illegible]	0.1	[illegible]
KPEG	617.6	59.4	36[illegible]8.1	0.0	0.0	1.9	1185.6	9.5	581[illegible].6	95.1	[illegible]	[illegible]	[illegible]	0.7	[illegible]
WATER	471.6	17.8	8[illegible]4.5	0.0	0.0	0.0	0.0	.2	10[illegible].1	[illegible]	[illegible]	[illegible]	11[illegible].3	[illegible]	[illegible]
XAD ././TENAX	27.9	3.3	95.2	0.0	0.0	0.7	18.4	1.0	27.9	10.[illegible]	[illegible].0	[illegible]	[illegible]	[illegible]	[illegible].4
TOTAL IN TREATED SOIL			4[illegible]559.8		71.0		1204.0		68[illegible].1		[illegible]		[illegible]		[illegible]
% REMAINING (AMOUNT RECOVERED OR NOT DESTROYED)			13.0		2.1		[illegible].5		104.2		[illegible]		[illegible]		[illegible].1

SAMPLE NO SAPM-IV

MATRIX	SAMPLE SIZE	CONC. ACETONE	QUANTITY IN TOTAL SAMPLE	CONC. 1,2 DI	QUANTITY IN TOTAL SAMPLE	CONC. TETRAC	QUANTITY IN TOTAL SAMPLE	CONC. CHLORO	QUANTITY IN TOTAL SAMPLE	CONC. ETHYL	QUANTITY IN TOTAL SAMPLE	CONC. XYLENE	QUANTITY IN TOTAL SAMPLE	CONC. XYLENE	QUANTITY IN TOTAL SAMPLE
UNTREATED SOIL	502.9	5055.0	1550[illegible]1.1	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TREATED SOIL	4[illegible]	3.1	1[illegible]50.0	[illegible]	0.6	0.2	[illegible]	.0	4.6	0.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
KPEG	6[illegible]2.9	16[illegible]3.0	10[illegible]	0.0	0.0	4.9	[illegible]	[illegible]	[illegible].4	1801.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
WATER	500.0	2[illegible]3.0	15[illegible]00.0	0.0	0.6	0.0	[illegible]	[illegible]	13250.0	206.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
XAD ././TENAX	30.[illegible]	11.8	[illegible]	0.1	[illegible].1	[illegible]	[illegible]	[illegible]	55.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL IN TREATED SOIL			[illegible]		[illegible].1		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]
% REMAINING (AMOUNT RECOVERED			[illegible]		.0		[illegible]		[illegible].7		[illegible]		[illegible]		[illegible]

Table

2ND TEST

SAMPLE NO. 6M-1 CONCENTRATION OF ANALYTE µg/g)

MATRIX	SAMPLE SIZE	CONC. ACETONE	QUANTITY IN TOTAL SAMPLE	CONC. 1,2-DI	QUANTITY IN TOTAL SAMPLE	CONC. TETRAC	QUANTITY IN TOTAL SAMPLE	CONC. CHLORO	QUANTITY IN TOTAL SAMPLE	CONC. ETHYL	QUANTITY IN TOTAL SAMPLE	CONC. XYLENE	QUANTITY IN TOTAL SAMPLE	CONC. STYRENE	QUANTITY IN TOTAL SAMPLE
UNTREATED SOIL	105.3	7885.0	830290.5	584.0	61495.2	585.0	61600.5	345.0	36328.5	3917.0	412460.1	10065.0	1059633.9	827.0	87085.1
TREATED SOIL	89.0	75.8	6746.2	0.0	0.0	0.7	60.9	8.0	712.0	95.2	8472.8	265.0	23585.0	27.0	2403.0
KPEG	210.0	1392.0	292320.0	0.0	0.0	1.9	401.1	254.0	53340.0	1894.0	397740.0	5586.0	1173060.0	554.0	116340.0
WATER	113.1	250.0	28015.0	0.0	0.0	0.0	0.0	35.2	3981.1	163.0	18435.3	413.0	46710.3	79.0	8934.9
XAD-2/TENAX	34.7	406.0	14088.2	1.8	62.1	10.8	374.8	12.7	440.7	164.0	5690.8	409.0	14192.3	31.1	1079.2
TOTAL IN TREATED SOIL			339167.4		62.1		836.7		58473.8		430338.9		1257547.6		128757.1
% REMAINING (AMOUNT RECOVERED OR NOT DESTROYED)			40.8		0.1		1.4		161.0		104.3		118.7		147.9

SAMPLE NO. SAPM-II

MATRIX	SAMPLE SIZE	CONC. ACETONE	QUANTITY IN TOTAL SAMPLE	CONC. 1,2-DI	QUANTITY IN TOTAL SAMPLE	CONC. TETRAC	QUANTITY IN TOTAL SAMPLE	CONC. CHLORO	QUANTITY IN TOTAL SAMPLE	CONC. ETHYL	QUANTITY IN TOTAL SAMPLE	CONC. XYLENE	QUANTITY IN TOTAL SAMPLE	CONC. STYRENE	QUANTITY IN TOTAL SAMPLE
UNTREATED SOIL	106.9	212.0	22662.8	0.2	20.6	23.5	2512.2	4.3	455.4	28.4	3036.0	101.0	10796.9	123.0	13148.7
TREATED SOIL	130.7	14.7	1921.3	0.0	0.0	2.2	288.8	0.1	19.1	0.9	115.3	2.9	381.6	0.5	63.8
KPEG	179.9	284.0	51091.6	0.0	0.0	1.5	266.3	4.4	791.6	47.6	8563.2	155.0	27884.5	17.4	3130.3
WATER	122.2	12.2	1490.8	0.0	0.0	0.0	0.0	1.6	194.3	8.8	1080.2	31.1	3800.4	4.9	596.3
XAD-2/TENAX	35.3	28.3	999.0	0.0	0.0	0.9	31.8	0.0	0.0	2.2	76.6	5.4	189.9	20.1	709.5
TOTAL IN TREATED SOIL			55502.7		0.0		586.9		1004.9		9835.4		32256.5		4499.9
% REMAINING (AMOUNT RECOVERED OR NOT DESTROYED)			244.9		0.0		23.4		220.7		324.0		298.8		34.2

SAMPLE NO. SAPM-III

MATRIX	SAMPLE SIZE	CONC. ACETONE	QUANTITY IN TOTAL SAMPLE	CONC. 1,2-DI	QUANTITY IN TOTAL SAMPLE	CONC. TETRAC	QUANTITY IN TOTAL SAMPLE	CONC. CHLORO	QUANTITY IN TOTAL SAMPLE	CONC. ETHYL	QUANTITY IN TOTAL SAMPLE	CONC. XYLENE	QUANTITY IN TOTAL SAMPLE	CONC. STYRENE	QUANTITY IN TOTAL SAMPLE
UNTREATED SOIL	116.7	496.0	57883.2	6.6	773.7	27.2	3174.2	13.1	1528.8	188.0	21939.6	500.0	58350.0	40.5	4726.4
TREATED SOIL	130.4	15.6	2034.2	0.0	0.0	1.3	165.6	0.5	59.6	3.1	397.7	9.8	1272.7	0.8	99.9
KPEG	191.3	169.0	32329.7	0.0	0.0	2.3	438.1	8.1	1540.0	76.5	14634.5	244.0	46677.2	18.1	3462.5
WATER	116.5	13.7	1596.1	0.0	0.0	0.0	0.0	2.1	248.1	13.7	1596.1	47.3	5510.5	5.2	608.1
XAD-2/TENAX	36.6	42.3	1548.2	0.1	3.7	1.2	45.2	0.4	15.8	10.0	366.0	26.3	962.6	16.1	589.3
TOTAL IN TREATED SOIL			37508.2		3.7		646.9		1863.5		16994.2		54422.9		4759.8
% REMAINING (AMOUNT RECOVERED OR NOT DESTROYED)			64.8		0.5		20.4		121.9		77.5		93.3		100.7

SAMPLE NO. SAPM-IV

MATRIX	SAMPLE SIZE	CONC. ACETONE	QUANTITY IN TOTAL SAMPLE	CONC. 1,2-DI	QUANTITY IN TOTAL SAMPLE	CONC. TETRAC	QUANTITY IN TOTAL SAMPLE	CONC. CHLORO	QUANTITY IN TOTAL SAMPLE	CONC. ETHYL	QUANTITY IN TOTAL SAMPLE	CONC. XYLENE	QUANTITY IN TOTAL SAMPLE	CONC. STYRENE	QUANTITY IN TOTAL SAMPLE
UNTREATED SOIL	97.9	3059.0	299476.1	151.0	14782.9	120.5	123843.5	387.0	37887.3	2916.0	285476.4	7451.0	729452.9	721.0	70585.9
TREATED SOIL	115.7	250.0	28925.0	0.0	0.0	1.9	214.0	3.7	426.9	38.0	4396.6	88.6	10251.0	13.0	1504.1
KPEG	178.9	1208.0	216111.2	0.0	0.0	0.0	0.0	242.0	43293.8	1764.0	316474.1	5501.0	984128.9	569.0	101794.1
WATER	120.8	13.2	1594.6	0.0	0.0	0.5	60.4	25.7	3104.6	82.1	9917.7	265.0	32012.0	66.6	8045.3
XAD-2/TENAX	35.7	487.0	17385.9	5.0	176.7	26.9	960.3	17.8	635.5	172.0	6140.4	461.0	16457.7	45.5	1624.4
TOTAL IN TREATED SOIL			264016.7		176.7		1234.8		47460.8		336928.8		1042849.6		112967.8
% REMAINING (AMOUNT RECOVERED OR NOT DESTROYED)			88.2		1.2		1.0		125.3		118.0		143.0		160.0

Table 13

First Test

PEI Soil Sample No.	WSU KPEG Treatment Number	WSU Run Number	Sample Type	Concentration (ug/kg) Anthracene	DEHP	Fraction Weight (g)	Total Quantity (mg) Anthracene	DEHP
SARM-I-1	---	---	Listed Levels	6,600,000	2,500,000	505.6	3337.0	1264.0
SARM-I-1	---	PEISV0058	Untreated soil	4,554,420	539,680	505.6	2302.7	272.9
SARM-I-1	SARM-I-1	PEISV0070	Treated soil	395,500	33,880	572.7	226.5	19.4
SARM-I-1	SARM-I-1	PEISV0072	KPEG	667,480	24,280	594.1	396.5	14.4
SARM-I-1	SARM-I-1	PEISV0073	Water	270,536	3,916	466.4	126.2	1.8
SARM-I-1	SARM-I-1	--- Destruction Totals ---					[749.2]	[35.6]
SARM-II-1	---	---	Listed Levels	660,000	250,000	506.0	334.0	126.5
SARM-II-1	---	PEISV0064	Untreated soil	227,540	40,200	506.0	115.1	20.3
SARM-II-1	SARM-II-2	PEISV0038	Treated soil	55,583	1,773	529.2	29.4	0.9
SARM-II-1	SARM-II-2	PEISV0074	KPEG	105,870	2,990	625.0	66.2	1.9
SARM-II-1	SARM-II-2	PEISV0075	Water	11,102	1,612	477.5	5.3	0.8
SARM-II-1	SARM-II-2	--- Destruction Totals ---					[100.9]	[3.6]
SARM-III-2	---	---	Listed Levels	660,000	250,000	504.5	333.0	126.1
SARM-III-2	---	PEISV0063	Untreated soil	13,740	62,240	504.5	6.9	31.4
SARM-III-2	SARM-III-2	PEISV0062	Treated soil	81,127	4,436	552.2	44.8	2.4
SARM-III-2	SARM-III-2	PEISV0077	KPEG	186,847	7,529	612.6	114.5	4.6
SARM-III-2	SARM-III-2	PEISV0078	Water	22,980	1,507	471.6	10.8	0.7
SARM-III-2	SARM-III-2	--- Destruction Totals ---					[170.1]	[7.7]
SARM-IV-1	---	---	Listed Levels	6,600,000	2,500,000	502.9	3319.1	1257.3
SARM-IV-1	---	PEISV0059	Untreated soil	4,210,040	936,560	502.9	2117.2	470.7
SARM-IV-1	SARM-IV-1	PEISV0071	Treated soil	167,380	27,420	462.7	77.4	12.7
SARM-IV-1	SARM-IV-1	PEISV0079	KPEG	66,960	37,140	662.9	44.4	24.6
SARM-IV-1	SARM-IV-1	PEISV0080	Water	821,481	11,592	500.0	410.7	5.8
SARM-IV-1	SARM-IV-1	--- Destruction Totals ---					[532.5]	[43.1]

Table 14

First Test

PEI Soil Sample No.	WSU KPEG Treatment Number	WSU Run Number	Sample Type	Concentration (ug/kg) PentaChloroPhenol	Fraction Weight (g)	Total Quantity (mg) PentaChloroPhenol
SARM-I-1	---------	---------	Listed Levels	1,000,000	505.6	505.6
SARM-I-1	---------	PEIPCP0011	Untreated soil	242,670	505.6	122.7
SARM-I-1	SARM-I-1	PEIPCP0030	Treated soil	4,732	572.7	2.7
SARM-I-1	SARM-1-1	PEIPCP0031	KPEG	212,255	594.1	126.1
SARM-I-1	SARM-1-1	PEIPCP0032	Water	15,461	466.4	7.2
SARM-I-1	SARM-1-1	--- Destruction Totals ---				[136.0]
SARM-II-1	---------	---------	Listed Levels	100,000	506.0	50.6
SARM-II-1	---------	PEIPCP0025	Untreated soil	3,970	506.0	2.0
SARM-II-1	SARM-II-1	PEIPCP0033	Treated soil	324	529.2	0.2
SARM-II-1	SARM-II-1	PEIPCP0034	KPEG	11,133	625.0	7.0
SARM-II-1	SARM-II-1	PEIPCP0035	Water	1,199	477.5	0.6
SARM-II-1	SARM-II-1	--- Destruction Totals ---				[7.8]
SARM-III-2	---------	---------	Listed Levels	100,000	504.5	50.4
SARM-III-2	---------	PEIPCP0019	Untreated soil	61,590	504.5	31.1
SARM-III-2	SARM-III-2	PEIPCP0037	Treated soil	225	552.2	0.1
SARM-III-2	SARM-III-2	PEIPCP0038	KPEG	17,511	612.6	10.7
SARM-III-2	SARM-III-2	PEIPCP0039	Water	1,142	471.6	0.5
SARM-III-2	SARM-III-2	--- Destruction Totals ---				[11.3]
SARM-IV-1	---------	---------	Listed Levels	1,000,000	502.9	502.9
SARM-IV-1	---------	PEIPCP0018	Untreated soil	85,009	502.9	42.8
SARM-IV-1	SARM-IV-1	PEIPCP0040	Treated soil	3,640	462.7	1.7
SARM-IV-1	SARM-IV-1	PEIPCP0041	KPEG	53,575	662.9	35.5
SARM-IV-1	SARM-IV-1	PEIPCP0043	Water	3,532	500.0	1.8
SARM-IV-1	SARM-IV-1	--- Destruction Totals ---				[39.0]

Table 15

Second Test

PEI Soil Sample No.	WSU KPEG Treatment Number	WSU Run Number	Sample Type	Concentration (ug/kg) Anthracene	Concentration (ug/kg) DEHP	Fraction Weight (g)	Total Quantity (mg) Anthracene	Total Quantity (mg) DEHP
SARM-I-1	---------	---------	Listed Levels	6,600,000	2,500,000	105.3	695.0	263.3
SARM-I-1	---------	PEISV0058	Untreated soil	4,554,420	539,680	105.3	479.6	56.8
SARM-I-1	PEI7-1-1A	PEISV0047	Treated soil	167,100	13,200	89.0	14.8	1.8
SARM-I-1	PEI7-1-1A	PEISV0040	KPEG	579,360	115,820	210.0	121.7	24.3
SARM-I-1	PEI7-1-1A	PEISV0041	Water	212,716	35,144	113.1	24.1	4.0
SARM-I-1	PEI7-1-1A	--- Destruction Totals ---					[160.7]	[29.5]
SARM-II-1	---------	---------	Listed Levels	660,000	250,000	106.9	70.6	26.7
SARM-II-1	---------	PEISV0064	Untreated soil	227,540	40,200	106.9	24.3	4.3
SARM-II-1	PEI7-2-1A	PEISV0037	Treated soil	251,050	3,696	130.7	32.8	0.5
SARM-II-1	PEI7-2-1A	PEISV0051	KPEG	161,962	2,018	179.9	29.1	0.4
SARM-II-1	PEI7-2-1A	PEISV0054	Water	3,650	1,017	122.2	0.4	0.1
SARM-II-1	PEI7-2-1A	--- Destruction Totals ---					[62.3]	[1.0]
SARM-III-2	---------	---------	Listed Levels	660,000	250,000	116.7	77.0	29.2
SARM-III-2	---------	PEISV0063	Untreated soil	13,740	62,240	116.7	1.6	7.3
SARM-III-2	PEI7-3-1A	PEISV0050	Treated soil	185,186	3,322	130.4	24.1	0.4
SARM-III-2	PEI7-3-1A	PEISV0052	KPEG	172,883	1,983	190.3	32.9	0.4
SARM-III-2	PEI7-3-1A	PEISV0056	Water	2,442	1,884	116.5	0.3	0.2
SARM-III-2	PEI7-3-1A	--- Destruction Totals ---					[57.3]	[1.0]
SARM-IV-1	---------	---------	Listed Levels	6,600,000	2,500,000	97.9	646.1	244.8
SARM-IV-1	---------	PEISV0059	Untreated soil	4,210,040	936,560	97.9	412.2	91.7
SARM-IV-1	PEI7-4-1A	PEISV0048	Treated soil	124,960	23,180	115.7	14.5	2.7
SARM-IV-1	PEI7-4-1A	PEISV0053	KPEG	126,730	1,880	178.9	22.7	0.3
SARM-IV-1	PEI7-4-1A	PEISV0057	Water	44,573	144	120.8	5.4	0.0
SARM-IV-1	PEI7-4-1A	--- Destruction Totals ---					[42.6]	[3.0]

Table 16

Second Test

PEI Soil Sample No.	WSU KPEG Treatment Number	WSU Run Number	Sample Type	Concentration (ug/kg) PentaChloroPhenol	Fraction Weight (g)	Total Quantity (mg) PentaChloroPhenol
SARM-I-1	---------	---------	Listed Levels	1,000,000	105.3	105.3
SARM-I-1	---------	PEIPCP0011	Untreated soil	242,670	105.3	25.6
SARM-I-1	PEI7-1-1A	PEIPCP0008	Treated soil	5,665	89.0	0.5
SARM-I-1	PEI7-1-1A	PEIPCP0009	KPEG	686,320	210.0	144.1
SARM-I-1	PEI7-1-1A	PEIPCP0010	Water	204,865	113.1	23.2
SARM-I-1	PEI7-1-1A	--- Destruction Totals ---				[167.8]
SARM-II-1	---------	---------	Listed Levels	100,000	106.9	10.7
SARM-II-1	---------	PEIPCP0025	Untreated soil	3,970	106.9	0.4
SARM-II-1	PEI7-2-1A	PEIPCP0026	Treated soil	217	130.7	0.0
SARM-II-1	PEI7-2-1A	PEIPCP0027	KPEG	1,593	179.9	0.3
SARM-II-1	PEI7-2-1A	PEIPCP0028	Water	523	122.2	0.1
SARM-II-1	PEI7-2-1A	--- Destruction Totals ---				[0.4]
SARM-III-2	---------	---------	Listed Levels	100,000	116.7	11.7
SARM-III-2	---------	PEIPCP0019	Untreated soil	61,590	116.7	7.2
SARM-III-2	PEI7-3-1A	PEIPCP0022	Treated soil	594	130.4	0.1
SARM-III-2	PEI7-3-1A	PEIPCP0023	KPEG	2,696	190.3	0.5
SARM-III-2	PEI7-3-1A	PEIPCP0024	Water	736	116.5	0.1
SARM-III-2	PEI7-3-1A	--- Destruction Totals ---				[0.7]
SARM-IV-1	---------	---------	Listed Levels	1,000,000	97.9	97.9
SARM-IV-1	---------	PEIPCP0018	Untreated soil	85,009	97.9	8.3
SARM-IV-1	PEI7-4-1A	PEIPCP0013	Treated soil	3,895	115.7	0.4
SARM-IV-1	PEI7-4-1A	PEIPCP0014	KPEG	320,590	178.9	57.4
SARM-IV-1	PEI7-4-1A	PEIPCP0017	Water	82,096	120.8	9.9
SARM-IV-1	PEI7-4-1A	--- Destruction Totals ---				[67.7]

Table 17

Blank Analysis

PEI Soil Sample No.	WSU KPEG Treatment Number	WSU Run Number	Sample Type	Total Quantity (ug) in Extract		Assumed Sample Weight (g)	Effective Quantity (mg)	
				Anthracene	DEHP		Anthracene	DEHP
--------	---------	PEISV0081	Method Blank	0.0115	0.1296	0.20	0.06	0.65

Table 18

Blank Analysis

PEI Soil Sample No.	WSU KPEG Treatment Number	WSU Run Number	Sample Type	Total Quantity (ug) in Extract PentaChloroPhenol	Assumed Sample Weight (g)	Effective Quantity (mg) PentaChloroPhenol
--------	---------	PEIPCP0044	Method Blank	0.0461	0.20	0.23

Table 19

Percent Recovery of Surrogate Standard

WSU Run Number	% Rec d10 - Anthracene
PEISV0037	51.4
PEISV0038	36.3
PEISV0040	41.2
PEISV0041	111
PEISV0047	51.9
PEISV0048	152
PEISV0050	94.3
PEISV0051	71.1
PEISV0052	80.2
PEISV0053	61.2
PEISV0054	44.0
PEISV0056	96.6
PEISV0057	98.4
PEISV0058	132
PEISV0059	86.9
PEISV0062	72.8
PEISV0063	90.4
PEISV0064	41.5
PEISV0070	84.6
PEISV0071	58.2
PEISV0072	26.6
PEISV0073	51.8
PEISV0074	153
PEISV0075	21.4
PEISV0077	82.5
PEISV0078	48.6
PEISV0079	67.0
PEISV0080	76.2
PEISV0081	58.9

Table 20

Percent Recovery of Surrogate Standard

WSU Run Number	% Rec c13 - PentaChloroPhenol
PEIPCP0008	23.0
PEIPCP0009	227
PEIPCP0010	148
PEIPCP0011	34.0
PEIPCP0013	12.0
PEIPCP0014	116
PEIPCP0017	77.5
PEIPCP0018	15.8
PEIPCP0019	85.3
PEIPCP0022	10.4
PEIPCP0023	6.3
PEIPCP0024	5.0
PEIPCP0025	15.4
PEIPCP0026	8.1
PEIPCP0027	4.9
PEIPCP0028	3.7
PEIPCP0030	13.6
PEIPCP0031	65.3
PEIPCP0032	9.8
PEIPCP0033	15.7
PEIPCP0034	26.1
PEIPCP0035	6.0
PEIPCP0037	8.3
PEIPCP0038	31.0
PEIPCP0039	7.0
PEIPCP0040	16.6
PEIPCP0041	22.4
PEIPCP0043	4.3
PEIPCP0044	22.2

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FIRST TEST CO RATION OF ANALYTES

SAMPLE NO. SARM-I

MATRIX	SAMPLE SIZE	CONC. ANTHRACENE (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. DEHP (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. PENTACHLOROPHENOL (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)
UNTREATED SO	505.6	4554420	2302.7	539680	272.9	242670	122.7
TREATED SOIL	572.7	395500	226.5	33880	19.4	4732	2.7
KPEG	594.1	667480	396.5	24280	14.4	212255	126.1
WATER	466.4	270536	126.2	3916	1.8	15461	7.2
TOTAL IN TREATED SOIL			749.2		35.7		136.0
% REMAINING (AMOUNT RECOVERED OR NOT DESTROYED)			32.5		13.1		110.9

SAMPLE NO. SARM-II

MATRIX	SAMPLE SIZE	CONC. ANTHRACENE (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. DEHP (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. PENTACHLOROPHENOL (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)
UNTREATED SO	506	227540	115.1	40200	20.3	3970	2.0
TREATED SOIL	529.2	55583	29.4	1773	0.9	324	0.2
KPEG	625	105370	66.2	2990	1.9	11133	7.0
WATER	477.5	11102	5.3	1612	0.8	1199	0.6
TOTAL IN TREATED SOIL			100.9		3.6		7.7
% REMAINING (AMOUNT RECOVERED OR NOT DESTROYED)			87.6		17.6		383.4

SAMPLE NO. SARM-III

MATRIX	SAMPLE SIZE	CONC. ANTHRACENE (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. DEHP (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. PENTACHLOROPHENOL (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)
UNTREATED SO	504.5	13740	6.9	62240	31.4	61590	31.1
TREATED SOIL	552.2	81127	44.8	4436	2.4	225	0.1
KPEG	612.6	186847	114.5	7529	4.6	17511	10.7
WATER	471.6	22980	10.8	1507	0.7	1142	0.5
XAD-2/TENAX	27.9						
TOTAL IN TREATED SOIL			170.1		7.8		11.4
% REMAINING (AMOUNT RECOVERED OR NOT DESTROYED)			2453.9		24.8		36.7

SAMPLE NO. SARM-IV

MATRIX	SAMPLE SIZE	CONC. ANTHRACENE (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. DEHP (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. PENTACHLOROPHENOL (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)
UNTREATED SO	502.9	4210040	2117.2	936560	471.0	85009	42.8
TREATED SOIL	462.7	167380	77.4	27420	12.7	3640	1.7
KPEG	662.9	66960	44.4	37140	24.6	53575	35.5
WATER	500	821481	410.7	11592	5.8	3532	1.8
XAD-2/TENAX	30.5						
TOTAL IN TREATED SOIL			532.6		43.1		39.0
% REMAINING (AMOUNT RECOVEPED OR NOT DESTROYED)			25.2		9.2		91.1

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SECOND TEST — NITRATION OF ANALYTES

SAMPLE NO. SARM-I

MATRIX	SAMPLE SIZE	CONC. ANTHRACENE (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. DEHP (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. PENTACHLOROPHENOL (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)
UNTREATED SO	105.3	4554420	479.6	539680	56.8	242670	25.6
TREATED SOIL	89	167100	14.9	13200	1.2	5665	0.5
KPEG	210	579360	121.7	115820	24.3	686320	144.1
WATER	113.1	212716	24.1	35144	4.0	204865	23.2
TOTAL IN TREATED SOIL			160.6		29.5		167.8
% REMAINING (AMOUNT RECOVERED OR NOT DESTROYED)			33.5		51.9		656.7

SAMPLE NO. SARM-II

MATRIX	SAMPLE SIZE	CONC. ANTHRACENE (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. DEHP (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. PENTACHLOROPHENOL (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)
UNTREATED SO	106.9	227540	24.3	40200	4.3	3970	0.4
TREATED SOIL	130.7	251050	32.8	3696	0.5	217	.0
KPEG	179.9	161962	29.1	2018	0.4	1593	0.3
WATER	122.2	3650	0.4	1017	0.1	523	0.1
TOTAL IN TREATED SOIL			62.4		1.0		0.4
% REMAINING (AMOUNT RECOVERED OR NOT DESTROYED)			256.5		22.6		89.3

SAMPLE NO. SARM-III

MATRIX	SAMPLE SIZE	CONC. ANTHRACENE (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. DEHP (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. PENTACHLOROPHENOL (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)
UNTREATED SO	116.7	13740	1.6	62240	7.3	61590	7.2
TREATED SOIL	130.4	185186	24.1	3322	0.4	594	0.1
KPEG	190.3	172383	32.9	1983	0.4	2696	0.5
WATER	116.5	2442	0.3	1884	0.2	736	0.1
TOTAL IN TREATED SOIL			57.3		1.0		0.7
% REMAINING (AMOUNT RECOVERED OR NOT DESTROYED)			3575.5		14.2		9.4

SAMPLE NO. SARM-IV

MATRIX	SAMPLE SIZE	CONC. ANTHRACENE (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. DEHP (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)	CONC. PENTACHLOROPHENOL (ug/kg)	QUANTITY IN TOTAL SAMPLE (mg)
UNTREATED SO	97.9	4210040	412.2	936560	91.7	85009	8.3
TREATED SOIL	115.7	124960	14.5	23180	2.7	3835	0.5
KPEG	178.9	126730	22.7	1880	0.3	320590	57.4
WATER	120.8	44573	5.4	144	.0	82036	9.9
TOTAL IN TREATED SOIL			42.5		3.0		67.7
% REMAINING (AMOUNT RECOVERED OR NOT DESTROYED)			10.3		3.3		813.7

ORD - TSI - RT - E - TV

WRIGHT STATE

Wright State University
Dayton, Ohio 45435

December 4, 1987

Mr. Bart Thompson
U.S. Environmental Protection Agency
Mail Code WH-548E
401 M Street, S.W.
Washington, D.C.20460

Dear Mr. Thompson:

The purpose of this letter is to provide you with a status report on our investigations relating to the Development of Treatment Data on the KPEG Process for SARA/BDAT Standards for the U.S. EPA, and to apprise you of the major problems and difficulties which we have encountered in the analytical portions of this work, which have resulted directly in the lengthy delays experienced in Wright State's completion of the project. Wright State's work on this project is being accomplished under Subcontract No. 777-87 to prime Contract No. 68-03-3413 between PEI Associates, Inc. and the U.S. Environmental Protection Agency. The brief report presented here is intended primarily to indicate to you the trends and overall conclusions which can be derived from the data obtained thus far (and the limitations of the data) in the hope that this will permit some useful comparisons with other destruction and/or removal technology which EPA is attempting to evaluate in this program. A more comprehensive report will be presented upon completion of the project, probably within the next week.

The procedures and techniques developed and implemented in this program by Wright State in evaluating the KPEG Process have been described in detail in documentation which Wright State has submitted to PEI Associates, Inc. and in the Quality Assurance Plan for the project which was jointly prepared by PEI and Wright State. Briefly, Wright State received from PEI four (4) soil samples prepared by that organization to contain known amounts of the volatile organic compounds, acetone, 1,2-dichloroethane, tetrachloroethylene, chlorobenzene, ethyl benzene, xylene and styrene, as well as the semivolatile organics, anthracene, bis-(2-ethylhexyl)phthalate and pentochlorophenol. These soils also contain the metals, cadmium, copper, chromium, lead, arsenic, nickel and zinc. The concentrations of these components were different in the four samples provided, but in all cases were quite large, being several orders of magnitude higher than the concentrations usually encountered in the environment. Wright State initially treated these soils by reacting portions or aliquots of each soil (in duplicate) with KOH and KPEG in closed laboratory reactors at a controlled temperature (100°C) for a

period of 2 hours. The treated samples were separated by phase, the spent KPEG in each reactor was removed from the residual soil and retained for analysis, the residual soils were washed with water, and the wash water and spent soil were separated and retained for analyses. A solid sorbent, used to trap volatile emissions from the reactor during treatment was also analyzed. A total of eight KPEG treatment tests were therefore accomplished (4 soils treated in duplicate) and four samples resulted from each test (spent soil, spent KPEG, soil wash water, volatile sorbent trap). Thus, 32 samples derived from the tests, and 8 samples of the original soils, or a total of 40 samples were to be analyzed by Wright State for all of the organic compounds known to be present in the spiked soils.

Metals analyses for the treated soils and starting materials were to be accomplished by Analytical Enterprises, Inc. of Columbus, SC, another U.S. EPA contractor. In addition, TCLP tests were to be conducted on these treated samples and the original soils by Wan Technologies of Atlanta, GA, also a U.S. EPA contractor. Immediately upon completion of the treatment experiments, on September 10, 1987, Wright State shipped portions of each of the several samples from the treatment process to these two laboratories by Federal Express. In addition, at that point, Wright State initiated attempts to analyze potions of these samples for the volatile and semi-volatile organic components of the soil. From the outset, these attempts were impeded by severe problems. Some of the problems encountered are outlined below:

1. The major source of problems encountered in the analyses originated from the huge concentrations of the analytes in the soil samples, and even in the samples resulting from the treatment tests. The magnitude of these concentrations was a problem because:

    a. The high concentrations required that relatively small aliquots of both the untreated soil and the several samples resulting from KPEG treatment be selected for analyses, in an attempt to avoid overloading the analytical devices utilized. It is virtually impossible to select a sample aliquot which is truly representative of the entire bulk sample when such small samples are taken for analysis.

    b. It was impossible to predict "a priori" the concentrations of the analytes which would be present in the various fractions from the treatment process, and therefore selection of portions of these samples which would yield adequate detection limits for the analytes of interest, but would avoid saturating or overloading the analytical devices, was largely a

matter of guess work. Unfortunately, very high concentrations of the organics were found to be present in many of these samples and therefore the "guesses" as to the portion of sample selected for analysis were frequently wrong. This lead to repeated saturation of the instrumentation and numerous repetitive analyses to get even marginally acceptable data. The performance of the Tekmar Purge-Trap apparatus is especially devastated by being subjected to very high saturating concentrations of organics, and this resulted in long "memory" or holdup of the compounds in the Purge-Trap apparatus. The result was that carry-over of analytes (from the previous run) occurred in many of the analyses and eliminating this (which was never completely accomplished for acetone) required purging the apparatus for many hours and even days between analyses. This ultimately required literally hundreds of analyses to obtain even passable results.

c. The extremely high concentrations present and detected in many of the treated samples were often outside the range of instrument calibration, again requiring many extra analyses.

d. The standard EPA procedures for analyzing compounds such as those encountered in these studies, as documented in EPA's SW846 Manual, were not applicable for various reasons and had to be modified extensively. For example, pentachlorophenol (PCP) could not be detected at all in the samples by direct injection of the sample extracts into the GC-MS, and it was necessary to acetylate or derivatize the PCP prior to injection. This essentially doubled the time normally required for such analyses.

e. There was strong evidence that the spiked soil samples provided by PEI were not homogeneous were received. Upon initial opening of the sample containers, condensation was observed on the can lid, and pools of liquid were apparent on the soil surface. The quantity of water present in the samples prevented effective mixing and representative subsampling. Finally, these soils were observed to contain rocks and other foreign matter which clearly indicated non-homogeneity and prevented accurate subsampling.

All of the above factors led to large variations in the analytical results and were directly responsible for the delays encountered in completing the analyses. Nevertheless, by major efforts, well in excess of those anticipated, our Laboratory has

completed a substantial portion of the required analyses. The data presented here include the following:

1) Metals Data: The measured concentrations of metals in all of the treated and untreated soil samples as reported by Analytical Enterprises have been converted to the total quantities of the untreated and treated samples, from our knowledge of total sample weights for each fraction analyzed. These results are shown in Tables 1-4, attached herewith.

2) Volatile Organics Data: Volatile organics data available at present are summarized in Tables 5-9 attached herewith. The designation "UN" following a sample number refers to the untreated soil. Similarly, the designations, "SO," "KP," "WA," and "XA," in Tables 5-9 refer to spent soil, spent KPEG, soil wash water, and XAD solid sorbent (used to trap evolved volatiles), respectively. The headings in these tables, "Acetone," "1,2-Di," "Tetra," "Chloro," "Ethyl," "Xylene," and "Styren" refer to acetone, 1,2-dichloroethane, tetrachloroethylene, chlorobenzene, ethyl benzene and styrene, respectively.

3) Semi-Volatile Organics Data: The data for semi-volatile organic compounds obtained thus far are summarized in Tables 10-13.

Several general conclusions are possible from these data, which are likely to remain valid even after all the analyses have been completed. These are:

a. The metals data indicate that few of the metals were effectively removed from the soils by the KPEG treatment and, subsequent water washing. Probably this is due to the inorganic forms of the metals and their relatively poor aqueous solubilities. In retrospect, extraction of these could probably have been enhanced by using an acid water wash of the spent soil after KPEG treatment. The overall materials balance for the metals is quite poor, however.

b. The volatile and semi-volatile organic data also exhibit very poor materials balances, but it seems clear that both 1,2- dichloroethane and tetrachloroethylene have essentially been completely destroyed by the KPEG treatment. The other chlorinated organics, chlorobenzene and pentachlorophenol, were not significantly affected by the KPEG treatment, which is not surprising, since it is known from other work, that destruction of these would have required higher temperatures than those used in the KPEG tests here. It was not practical to use such higher temperatures in these tests because of the flash points and volatility of the other

organics (acetone, particularly) present in these samples. The hydrocarbons (xylene, ethyl benzene and styrene) in these samples were not expected to be affected by the KPEG treatment, and indeed no effects on degradation of these are discernible. The data for acetone are so suspect in view of volatility problems and instrument saturation, background and holdup, as to be totally unreliable.

We hope that these results are useful in comparing the several technologies evaluated on this project and we are working vigorously to complete the full final report in the coming week. The delays in completing the analyses which we have encountered were beyond our control, but we regret that this has impeded the overall technology assessment.

Sincerely,

Thomas O. Tiernan, Ph.D.
Professor of Chemistry

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Attachments

TAble 1

RECOVERY OF METALS IN STANDARD ANALYTICAL REFERENCES MATRIX

	SAMPLE WEIGHT		ARSENIC FOUND ug/g	ARSENIC TOTAL		CADMIUM FOUND ug/g	CADMIUM TOTAL	
UNTREATED SOIL I-I	505.60	g	20.00	10112.00	ug	45.00	22752.00	ug
TREATED SOIL I-I	572.70	g	8.10	4638.87	ug	21.00	12026.70	ug
WASH WATER I-I	466.40	g	8.20	3824.48	ug	1.50	699.60	ug
SPENT REAGENT I-1	594.10	g	0.04	23.76	ug	2.40	1425.84	ug
			TOTAL	8487.11			TOTAL	1415[illegible].14
% REC IN SOIL				45.87			% REC IN SOIL	52.66
OVERALL REC				83.93			OVERALL REC	62.20
UNTREATED SOIL III-2	504.50	g	359.00	181115.50	ug	3480.00	1754696.00	ug
TREATED SOIL III-2	552.20	g	184.00	101604.80	ug	861.00	475444.20	ug
WASH WATER III-2	471.60	g	0.00	0.00	ug	1.80	848.88	ug
SPENT REAGENT III-2	612.60	g	1.20	735.12	ug	4.50	2756.70	ug
			TOTAL	102339.92			TOTAL	479049.78
% REC IN SOIL				56.10			% REC IN SOIL	27.02
OVERALL REC				56.51			OVERALL REC	27.[illegible]2
UNTREATED SOIL IV-1	502.90	g	338.00	169980.20	ug	[illegible]146.00	3091829.00	ug
TREATED SOIL IV-1	462.70	g	168.00	77733.60	ug	4055.00	2246408.50	ug
WASH WATER IV-1	500.00	g	450.00	225000.00	ug	4.50	2250.00	ug
SPENT REAGENT IV-1	662.90	g	96.00	63638.40	ug	7.10	4706.59	ug
			TOTAL	370372.00			TOTAL	2253365.09
% REC IN SOIL				45.73			% REC IN SOIL	72.66
OVERALL REC				217.89			OVERALL REC	72.88
UNTREATED SOIL II-I	506.00	g	20.00	10120.00	ug	59.00	29854.00	ug
TREATED SOIL II I	529.20	g	8.70	4604.04	ug	34.00	17992.80	ug
WASH WATER II-I	477.50	g	8.60	4106.50	ug	1.80	859.50	ug
SPENT REAGENT II-I	625.00	g	0.04	25.00	ug	6.30	3937.50	ug
			TOTAL	8735.54			TOTAL	22789.80
% REC IN SOIL				45.49			% REC IN SOIL	60.27
OVERALL REC				86.32			OVERALL REC	76.[illegible]4

Table 2

RECOVERY OF METALS IN STANDARD ANALYTICAL REFERENCES MATRIX

	SAMPLE WEIGHT	LEAD FOUND ug/g	LEAD TOTAL		NICKEL FOUND ug/g	NICKEL TOTAL	
UNTREATED SOIL I-1	505.60 g	304.00	153702.40	ug	48.00	24268.80	ug
TREATED SOIL I-1	571.70 g	195.00	111478.50	ug	42.00	18526.40	ug
WASH WATER I-1	466.40 g	6.80	3171.52	ug	2.00	932.80	ug
SPENT REAGENT I-1	594.10 g	18.00	10693.80	ug	8.40	4990.44	ug
		TOTAL	125541.82		TOTAL	24249.64	
% REC IN SOIL			72.66		% REC IN SOIL	53.30	
OVERALL REC			81.68		OVERALL REC	70.53	
UNTREATED SOIL III-2	504.50 g	14451.00	7290529.50	ug	2409.00	1215340.50	ug
TREATED SOIL III-2	552.20 g	11350.00	6267470.00	ug	1615.00	891803.00	ug
WASH WATER III-2	471.60 g	1970.00	929052.00	ug	4.00	2075.04	ug
SPENT REAGENT III-2	612.60 g	1435.00	879081.00	ug	3.00	1837.80	ug
		TOTAL	8075603.00		TOTAL	895715.84	
% REC IN SOIL			85.97		% REC IN SOIL	73.38	
OVERALL REC			110.77		OVERALL REC	73.70	
UNTREATED SOIL IV-1	502.90 g	17175.00	8637307.50	ug	2448.00	1231099.20	ug
TREATED SOIL IV-1	462.70 g	9827.00	4546952.90	ug	2332.00	1079016.40	ug
WASH WATER IV-1	500.00 g	1836.00	918000.00	ug	2.60	1300.00	ug
SPENT REAGENT IV-1	662.90 g	977.00	647653.30	ug	8.70	5767.23	ug
		TOTAL	6112606.20		TOTAL	1086083.63	
% REC IN SOIL			52.64		% REC IN SOIL	87.65	
OVERALL REC			70.77		OVERALL REC	88.22	
UNTREATED SOIL II-1	506.00 g	379.00	191774.00	ug	70.00	35420.00	ug
TREATED SOIL II-1	519.30 g	169.00	894.34.80	ug	34.00	17663.60	ug
WASH WATER II-1	477.50 g	18.20	8690.50	ug	2.20	1050.50	ug
SPENT REAGENT II-1	625.00 g	79.00	18125.00	ug	13.00	8125.00	ug
		TOTAL	116250.30		TOTAL	266374.10	
% REC IN SOIL			46.64		% REC IN SOIL	49.30	
OVERALL REC			60.62		OVERALL REC	75.21	

Table 3

RECOVERY OF METALS IN STANDARD ANALYTICAL REFERENCES MATRIX

	SAMPLE WEIGHT	CHROMIUM FOUND ug/g	CHROMIUM TOTAL		COPPER FOUND ug/g	COPPER TOTAL
UNTREATED SOIL I-1	505.60 g	30.00	15168.00	ug	349.00	176454.40
TREATED SOIL I-1	572.70 g	21.00	12026.70	ug	251.00	143747.70
WASH WATER I-1	966.40 g	0.97	937.41	ug	13.00	6963.20
SPENT REAGENT I-1	594.10 g	0.02	11.88	ug	7.90	4693.39
		TOTAL	12990.99		TOTAL	154504.29
% REC IN SOIL			79.29		% REC IN SOIL	81.46
OVERALL REC			82.35		OVERALL REC	87.56
UNTREATED SOIL III-2	504.50 g	1163.00	586733.50	ug	11078.00	5691551.00
TREATED SOIL III-2	552.70 g	826.00	456417.20	ug	6726.00	3716619.20
WASH WATER III-2	471.60 g	168.00	79228.80	ug	2861.00	1349139.60
SPENT REAGENT III-2	612.60 g	2.20	1347.72	ug	38.00	23278.80
		TOTAL	536993.72		TOTAL	5089037.60
% REC IN SOIL			77.74		% REC IN SOIL	65.33
OVERALL REC			91.47		OVERALL REC	89.40
UNTREATED SOIL IV-1	502.90 g	1407.00	707560.30	ug	10820.00	5495691.20
TREATED SOIL IV-1	462.70 g	918.00	424758.60	ug	9381.00	4340568.70
WASH WATER IV-1	500.00 g	174.00	87000.00	ug	454.00	227000.00
SPENT REAGENT IV-1	662.90 g	13.00	8617.70	ug	310.00	205699.00
		TOTAL	520376.30		TOTAL	4773267.70
% REC IN SOIL			60.03		% REC IN SOIL	78.78
OVERALL REC			73.54		OVERALL REC	86.85
UNTREATED SOIL II-1	506.00 g	33.00	16698.00	ug	376.00	190256.00
TREATED SOIL II-1	529.20 g	23.00	12171.60	ug	330.00	174636.00
WASH WATER II-1	477.50 g	6.60	3315.50	ug	20.00	9550.00
SPENT REAGENT II-1	625.00 g	0.02	12.50	ug	17.00	10625.00
		TOTAL	16099.60		TOTAL	194811.00
% REC IN SOIL			72.69		% REC IN SOIL	91.77
OVERALL REC			96.42		OVERALL REC	102.39

Table 4

RECOVERY OF METALS IN STANDARD ANALYTICAL REFERENCES MATRIX

	SAMPLE WEIGHT		ZINC FOUND ug/g	ZINC TOTAL	
UNTREATED SOIL I-1	505.60	g	1028.00	519756.80	ug
TREATED SOIL I-1	572.70	g	493.00	301768.40	ug
WASH WATER I-1	466.40	g	3.70	1725.68	ug
SPENT REAGENT I-1	594.10	g	3.30	1960.53	ug
			TOTAL	285454.61	
% REC IN SOIL				54.21	
OVERALL REC				54.32	
UNTREATED SOIL III-2	504.50	g	24262.00	1224179.00	ug
TREATED SOIL III-2	552.20	g	973.00	537230.60	ug
WASH WATER III-2	471.60	g	1960.00	927165.60	ug
SPENT REAGENT III-2	612.60	g	566.00	346731.60	ug
			TOTAL	1811127.80	
% REC IN SOIL				4.39	
OVERALL REC				14.80	
UNTREATED SOIL IV-1	502.90	g	23414.00	1177400.60	ug
TREATED SOIL IV-1	462.70	g	14736.00	6818347.20	ug
WASH WATER IV-1	500.00	g	2576.00	1288000.00	ug
SPENT REAGENT IV-1	662.90	g	933.00	618485.70	ug
			TOTAL	8724832.90	
% REC IN SOIL				57.91	
OVERALL REC				74.10	
UNTREATED SOIL II-1	506.00	g	1725.00	872850.00	ug
TREATED SOIL II-1	529.20	g	1269.00	671554.80	ug
WASH WATER II-1	477.50	g	10.00	4775.00	ug
SPENT REAGENT II-1	625.00	g	11.00	6875.00	ug
			TOTAL	683204.80	
% REC IN SOIL				76.94	
OVERALL REC				78.27	

Table 5

Wright State University, Dayton, Ohio 45435

Analysis for Destruction of Volatiles with KPEG

Concentrations Found (micrograms per gram of sample or parts-per-million)

PEI 1-1 Sample Number	Aceton	1,2-Di	Tetrac	Chloro	Ethyl	Xylene	Styren
SARM-1-1 UN	7885	584	585	345	3917	10063	827
SARM-1-1 SD	75.8	ND 0.0845	0.684	8.00	95.2	265	27.0
SARM-1-1 KP	1392	ND 0.807	ND 1.91	254	1894	5586	554
SARM-1-1 WA	230	ND 0.0370	ND 0.0548	35.2	163	413	79.0
SARM-1-1 XA	376	3.06	5.66	12.4	108	177	29.8

a. The designation ND indicates "None Detected" in excess of the minimum detectable concentration which is listed directly below the ND designation.

TAble 6

Wright State University, Dayton, Ohio 45435

Analysis for Destruction of Volatiles with KPEG

Concentrations Found (micrograms per gram of sample or parts-per-million)

PEI 1-2 Sample Number	Aceton	1,2-Di	Tetrac	Chloro	Ethyl	Xylene	Styren
SARM-2-1 UN	212	0.193	23.5	4.26	28.4	101	123
SARM-2-1 SD	14.7	ND 0.0262	2.21	0.146	0.882	2.92	0.488
SARM-2-1 KP	284	ND 0.312	1.48	4.40	47.6	155	17.4
SARM-2-1 WA	12.2	ND 0.0174	ND 0.0142	1.59	8.84	31.1	4.88
SARM-2-1 XA	28.3	ND 0.0698	0.854	ND 0.0552	2.17	5.38	20.1

a. The designation ND indicates "None Detected" in excess of the minimum detectable concentration which is listed directly below the ND designation.

Table 7

Wright State University, Dayton, Ohio 45435

Analysis for Destruction of Volatiles with KPEG

Concentrations Found (micrograms per gram of sample or parts-per-million)

PEI 1-3 Sample Number	Aceton	1,2-Di	Tetrac	Chloro	Ethyl	Xylene	Styren
SARM-3-2 UN	496	6.63	27.2	13.1	188	500	40.5
SARM-3-2 SO	15.6	ND 0.0200	1.27	0.457	3.05	9.76	0.766
SARM-3-2 KP	169	ND 0.384	2.29	8.05	76.5	244	18.1
SARM-3-2 WA	13.7	ND 0.0239	ND 0.0214	2.13	13.7	47.3	5.22

a. The designation ND indicates "None Detected" in excess of the minimum detectable concentration which is listed directly below the ND designation.

Table 8

Wrignt State University, Dayton, Ohio 45435

Analysis for Destruction of Volatiles with KPEG

Concentrations Found (micrograms per gram of samole or parts-per-million)

EI 1-4 Sample Number	Aceton	1,2-Di	Tetrac	Chloro	Ethyl	Xylene	Styren
ARM-4-1 UN	3059	151	1265	387	2916	7451	721
ARM-4-1 SO	250	ND 0.395	1.85	3.69	38.0	88.6	13.0
ARM-4-1 KP	1208	ND 1.07	ND 3.65	242	1769	5501	569
ARM-4-1 WA	13.2	ND 0.0571	0.503	25.7	82.1	265	66.6

a. The designation ND indicates "None Detected" in excess of the minimum detectable concentration which is listed directly below the ND designation.

Table 9

Wright State University, Dayton, Ohio 45435

Analysis for Destruction of Volatiles with KPEG

Concentrations Found (micrograms per gram of sample or parts-per-million)

EI SET 1 Sample Number	Aceton	1,2-Di	Tetrac	Chloro	Ethyl	Xylene	Styren
ARM-1-1 UN	7885	584	585	345	3917	10063	827
ARM-1 SOIL	3.46	ND 0.0018	0.140	0.106	1.05	3.67	0.367
ARM-2-1 UN	212	0.193	23.5	4.26	28.4	101	123
ARM-2 SOIL	7.59	0.0160	0.0129	0.0161	0.0718	0.247	0.0568
ARM-3-2 UN	496	6.63	27.2	13.1	188	500	40.5
ARM-3 SOIL	4.86	0.130	0.0068	0.0306	0.0318	0.280	0.0547
M-4-1 UN	3059	151	1265	387	2916	7451	721
ARM-4 SOIL	3.35	ND 0.0030	0.156	0.0102	0.0623	0.216	0.0349

a. The designation ND indicates "None Detected" in excess of the minimum detectable concentration which is listed directly below the ND designation.

Table 10

PEI Soil Sample No.	WSU KPEG Treatment Number	WSU Run Number	Sample Type	Concentration (ug/kg) Anthracene	Concentration (ug/kg) DEHP	Fraction Weight (g)	Total Quantity (mg) Anthracene	Total Quantity (mg) DEHP
SARM-I-1	---------	---------	Listed Levels	6,600,000	2,500,000	105.3	695.0	263.3
SARM-I-1	---------	PEISV0058	Untreated soil	4,554,420	539,680	105.3	479.6	56.8
SARM-I-1	PEI7-1-1A	PEISV0047	Treated soil	167,100	13,200	89.0	14.8	1.3
SARM-I-1	PEI7-1-1A	PEISV0040	KPEG	579,360	115,820	210.0	121.7	24.3
SARM-I-1	PEI7-1-1A	PEISV0041	Water	212,716	35,144	113.1	24.1	4.0
SARM-I-1	PEI7-1-1A	--- Destruction Totals					[160.7]	[29.5]
SARM-II-1	---------	---------	Listed Levels	660,000	250,000	106.9	70.6	26.7
SARM-II-1	---------	PEISV0064	Untreated soil	227,540	40,200	106.9	24.3	4.3
SARM-II-1	PEI7-2-1A	PEISV0037	Treated soil	251,050	3,696	130.7	32.8	0.5
SARM-II-1	PEI7-2-1A	PEISV0051	KPEG	161,962	2,018	179.9	29.1	0.4
SARM-II-1	PEI7-2-1A	PEISV0054	Water	3,650	1,017	122.2	0.4	0.1
SARM-II-1	PEI7-2-1A	--- Destruction Totals					[62.3]	[1.0]
SARM-III-2	---------	---------	Listed Levels	660,000	250,000	116.7	77.0	29.2
SARM-III-2	---------	PEISV0063	Untreated soil	13,740	62,240	116.7	1.6	7.3
SARM-III-2	PEI7-3-1A	PEISV0050	Treated soil	185,186	3,322	130.4	24.1	0.4
SARM-III-2	PEI7-3-1A	PEISV0052	KPEG	172,883	1,983	190.3	32.9	0.4
SARM-III-2	PEI7-3-1A	PEISV0056	Water	2,442	1,884	116.5	0.3	0.2
SARM-III-2	PEI7-3-1A	--- Destruction Totals					[57.3]	[1.0]
SARM-IV-1	---------	---------	Listed Levels	6,600,000	2,500,000	97.9	646.1	244.8
SARM-IV-1	---------	PEISV0059	Untreated soil	4,210,040	936,560	97.9	412.2	91.7
SARM-IV-1	PEI7-4-1A	PEISV0043	Treated soil	124,360	23,180	113.7	14.1	2.7
SARM-IV-1	PEI7-4-1A	PEISV0061	KPEG	126,700	1,680	178.9	22.7	0.3
SARM-IV-1	PEI7-4-1A	PEISV0057	Water	44,573	144	120.8	5.4	0.0
SARM-IV-1	PEI7-4-1A	--- Destruction Totals					[42.6]	[3.0]

Table 11

PEI Soil Sample No.	WSU KPEG Treatment Number	WSU Run Number	Sample Type	Concentration (ug/kg) Anthracene	Concentration (ug/kg) DEHP	Fraction Weight (g)	Total Quantity (kg) Anthracene	Total Quantity (kg) DEHP
SARM-I-1	---------	---------	Listed Levels	6,600,000	2,500,000	505.6	3337.0	1264.0
SARM-I-1	---------	PEISV0058	Untreated soil	4,554,420	539,680	505.6	2302.7	272.9
SARM-I-1	SARM-I-1	PEISV0070	Treated soil	395,500	33,880	572.7	226.5	19.4
SARM-I-1	SARM-I-1	PEISV0072	KPEG	667,480	24,280	594.1	396.5	14.4
SARM-I-1	SARM-I-1	PEISV0073	Water	270,536	3,916	466.4	126.2	1.3
SARM-I-1	SARM-I-1	--- Destruction Totals ---					[749.2]	[35.6]
SARM-II-1	---------	---------	Listed Levels	660,000	250,000	506.0	334.0	126.5
SARM-II-1	---------	PEISV0064	Untreated soil	227,540	40,200	506.0	115.1	20.3
SARM-II-1	SARM-II-2	PEISV0038	Treated soil	55,583	1,773	529.2	29.4	0.9
SARM-II-1	SARM-II-2	PEISV0074	KPEG	105,870	2,990	625.0	66.2	1.9
SARM-II-1	SARM-II-2	PEISV0075	Water	11,102	1,612	477.5	5.3	0.8
SARM-II-1	SARM-II-2	--- Destruction Totals ---					[100.9]	[3.6]
SARM-III-2	---------	---------	Listed Levels	660,000	250,000	504.5	333.0	126.1
SARM-III-2	---------	PEISV0063	Untreated soil	13,740	62,240	504.5	6.9	31.4
SARM-III-2	SARM-III-2	PEISV0062	Treated soil	81,127	4,436	552.2	44.8	2.4
SARM-III-2	SARM-III-2	PEISV0077	KPEG	186,847	7,529	612.6	114.5	4.6
SARM-III-2	SARM-III-2	PEISV0078	Water	22,980	1,507	471.6	10.8	0.7
SARM-III-2	SARM-III-2	--- Destruction Totals ---					[170.1]	[7.7]
SARM-IV-1	---------	---------	Listed Levels	6,600,000	2,500,000	502.9	3319.1	1257.3
SARM-IV-1	---------	PEISV0058	Untreated soil	4,210,040	539,680	502.9	2117.2	271.4
SARM-IV-1	SARM-IV-1	PEISV0071	Treated soil	167,300	27,420	462.7	77.4	12.7
SARM-IV-1	SARM-IV-1	PEISV0079	KPEG	66,961	37,140	662.9	44.4	24.6
SARM-IV-1	SARM-IV-1	PEISV0080	Water	821,481	11,592	500.0	410.7	5.8
SARM-IV-1	SARM-IV-1	--- Destruction Totals ---					[532.5]	[43.1]

Table 12

PEI Soil Sample No.	WSU KPEG Treatment Number	WSU Run Number	Sample Type	Total Quantity (ug) in Extract		Fraction Weight (g)	Total Quantity (mg)	
				Anthracene	DEHP		Anthracene	DEHP
--------	---------	PEISV0042	Method Blank	0.1345	5.209	500.0	0.367	2.60
						100.0	0.013	0.52
--------	---------	PEISV0081	Method Blank	0.0115	0.1296	500.0	0.008	0.65
						100.0	0.002	0.13

Table 13

PEI Soil Sample No.	WSU KPEG Treatment Number	WSU Run Number	Sample Type	Concentration (ug/kg) PentaChloroPhenol	Fraction Weight (g)	Total Quantity (mg) PentaChloroPhenol
SARM-I-1	----------	----------	Listed Levels	1,000,000	105.3	105.3
SARM-I-1	----------	PEIPCP0011	Untreated soil	242,670	105.3	25.6
SARM-I-1	PEI7-1-1A	PEIPCP0008	Treated soil	5,665	89.0	0.5
SARM-I-1	PEI7-1-1A	PEIPCP0009	KPEG	686,320	210.0	144.1
SARM-I-1	PEI7-1-1A	PEIPCP0010	Water	204,865	113.1	23.2
SARM-I-1	PEI7-1-1A	-- Destruction Totals				[167.8]
SARM-II-1	----------	----------	Listed Levels	100,000	106.9	10.7
SARM-II-1	----------	PEIPCP0025	Untreated soil	3,970	106.9	0.4
SARM-II-1	PEI7-2-1A	PEIPCP0026	Treated soil	217	130.7	0.0
SARM-II-1	PEI7-2-1A	PEIPCP0027	KPEG	1,593	179.9	0.3
SARM-II-1	PEI7-2-1A	PEIPCP0028	Water	523	122.2	0.1
SARM-II-1	PEI7-2-1A	-- Destruction Totals				[0.4]
SARM-III-2	----------	----------	Listed Levels	100,000	116.7	11.7
SARM-III-2	----------	PEIPCP0019	Untreated soil	61,590	116.7	7.2
SARM-III-2	PEI7-3-1A	PEIPCP0022	Treated soil	594	130.4	0.1
SARM-III-2	PEI7-3-1A	PEIPCP0023	KPEG	2,696	190.3	0.5
SARM-III-2	PEI7-3-1A	PEIPCP0024	Water	736	116.5	0.1
SARM-III-2	PEI7-3-1A	-- Destruction Totals				[0.7]
SARM-IV-1	----------	----------	Listed Levels	1,000,000	97.9	97.9
SARM-IV-1	----------	PEIPCP0018	Untreated soil	85,009	97.9	8.3
SARM-IV-1	PEI7-4-1A	PEIPCP0013	Treated soil	3,895	115.7	0.4
SARM-IV-1	PEI7-4-1A	PEIPCP0014	KPEG	320,590	178.9	57.4
SARM-IV-1	PEI7-4-1A	PEIPCP0017	Water	82,096	120.8	9.9
SARM-IV-1	PEI7-4-1A	-- Destruction Totals				[67.7]

REPORT ON METAL ANALYSES TO DEVELOPMENT OF TREATMENT DATA ON THE KPEG PROCESS FOR SARA/BDAT STANDARDS

Prime Contract No. 7C3072 YAWE
Subcontract No. 4-87-1-0275

Submitted To

Mr. Charles Rogers
U. S. Environmental Protection Agency

Mr. T. D. Ferguson
U. S. Environmental Protection Agency

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PEI

Prepared By

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SAMPLE INVENTORY

A total of sixteen (16) samples were received from Wright State University, 175 Brehm Research Laboratory, Dayton, Ohio 45435, on September 19, 1987. Samples were delivered by Federal Express. The contents of the package were examined for possible breakage and each sample was logged in AEI's Sample Log Book. All containers were intact and their was no damage to packed samples.

The Sample Inventory is given below:

SARM - EPA/PEI SAMPLE INVENTORY

1.	SARM - I - I	Untreated Soil
2.	SARM - II - I	Untreated Soil
3.	SARM - III - 2	Untreated Soil
4.	SARM - IV - 1	Untreated Soil
5.	SARM - I - I	Treated Soil
6.	SARM - II - I	Treated Soil
7.	SARM - III - 2	Treated Soil
8.	SARM - IV - 1	Treated Soil
9.	SARM - I - I	Spent Reagent
10.	SARM - II - 1	Spent Reagent
11.	SARM - III - 2	Spent Reagent
12.	SARM - IV - 1	Spent Reagent
13.	SARM - I - I	Wash Water
14.	SARM - II - 1	Wash Water
15.	SARM - III - 2	Wash Water
16.	SARM - IV - 1	Wash Water

SAMPLE PREPARATION AND ANALYSES

Based on the **"Statement of Work"** in Prime Contract No. 7C3072YAWE/Subcontract No. 4-87-1-0275, AEI was to analyze samples for the eight metals: Arsenic (As); Beryllium (Be); Cadmium (Cd); Chromium (Cr); Copper (Cu); Lead (Pb); Nickel (Ni) and Zinc (Zn).

The soil samples were sludges with considerable amounts of water present. An aliquot of each soil sample was weighed out and digested according to SWA-846, Method 3050 for all metals, except arsenic, with the final digestate taken up in a hydrochloric (HCl) acid matrix. A separate aliquot was digested for arsenic, with the final digestate existing in a nitric (HNO_3) acid medium. Aliquots of spent reagents and wash waters were digested according to Methods 3010 and 3005, respectively for arsenic. The remaining amounts of wash waters and spent reagents were digested for all the other metals.

Samples were analyzed for arsenic using a Perkin Elmer 5000 Atomic Absorption Spectrophotometer with Zeeman Background Correction, an HGA - 500, and an AS-40 Autosampler.

The other metals were determined in the prepared samples by use of Flame Atomic Absorption Spectrophotometry. Each sample was analyzed by using the method of standard additions. Blanks and spiked samples were also run.

The results of the sample analyses are reported in the attached table. All sample results are based on wet weight.

Concentration of Metals in Standard Analytical References Matrix - Potassium Polyethylene Glycol Treatment Samples

METALS
(μg metal/g sample)

	Arsenic	Beryllium	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
Treated Soil I-I	8.1	*Undetected	21	21	251	195	32	492
Untreated Soil I-I	20	Undetected	45	30	349	304	68	1,028
Treated Soil II-1	8.7	Undetected	34	23	330	169	33	1,269
Untreated Soil II-1	20	Undetected	59	33	376	379	70	1,725
Treated Soil III-2	184	Undetected	861	826	6,736	11,350	1,615	973
Untreated Soil III-2	359	Undetected	3,488	1,163	11,678	14,451	2,409	24,262
Treated Soil IV-1	168	Undetected	4,855	918	9,381	9,827	2,332	14,736
Untreated Soil IV-1	338	Undetected	6,148	1,407	10,928	17,175	2,448	23,414
Wash Water I-I	8.2	Undetected	1.5	0.97	13	6.8	2.0	3.7
Wash Water II-I	8.6	Undetected	1.8	8.2	20	18.2	2.2	10
Wash Water III-2	—	Undetected	1.8	168	281	1,970	4.4	1,966
Wash Water IV-1	458	Undetected	4.5	174	454	1,836	2.6	2,576
Spent Reagent I-I	Undetected (DL = .04 ng)	Undetected	2.4	Undetected (DL = 0.02)	7.9	18	8.4	[illegible]
Spent Reagent II-I	Undetected (DL = 0.04ng)		6.3	Undetected (DL = .02)	17	29	13	11
Spent Reagent III-2	1.2	Undetected	4.5	2.2	38	1,435	3.0	566
Spent Reagent IV-1	96	Undetected	7.1	13	310	977	8.7	933

***Detection Limit for beryllium is 0.01 μg/g.**